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COVER PHOTO

A scene from the Civil Defense film, "A Voice Shall Be Heard," depicting the effect, in a city square, of an imagined atomic blast. See story in this issue.

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EDITORIAL

In February of 1918 the 42nd Infantry (Rainbow) Division moved into the Lorraine Sector of the Western Front in France. At the start of this tour of duty, the sector was under French command, later the Americans assumed the command. The Division Commander was Maj. Gen. Charles T. Menoher, his Chief of Staff was Col. Douglas MacArthur.

As the sector was taken over, the French cautioned against any "unnecessary" military activity. It was pointed out that all artillery fire, for example, was answered in kind by the Germans. The French philosophy was, in effect, "Let live—and live."

This philosophy was NOT adopted by the Americans. As soon as they assumed command of the sector they began firing upon every worthwhile target. When the Germans responded in kind, we retaliated with more and more fire. This, of course, represented the practice and the philosophy not merely of the Rainbow Division but of the American forces in France. It is more than a coincidence that the war was over and won within eight months.

The French seemed to have pursued a philosophy of laissez faire in the war which began in September of 1939. Inevitably, this doctrine resulted in a crushing and disastrous defeat for the French armies and the fall of France as a Nation.

The most fundamental and unchanging military doctrine of the American Army is, "The best defense is a good offense." This, of course, has been the doctrine of every victorious army in the long history of war.

It is not a soft doctrine, nor one that is readily adopted by the soft-hearted. It implies seeking battle, and battles result in losses to your own as well as the enemy's forces.

Yet the ultimate result is calculated to reduce overall losses by shortening a war. In the long run the war which is the most economical in life, limb, suffering, hardship, and wealth is the war in which you hit the enemy as quickly and hard as you can, with everything you've got.

As far as the American army is concerned, "everything we've got" includes chemical, biological, and radiological weapons. Yet there seems to be a tacit understanding that we will not use these powerful and effective weapons. The basis for this understanding seems to be a concept that these weapons are "inhumane," in contrast to other weapons of war. Your Editor suggests that this is nonsense. If any of our readers can, in all seriousness, name just one "humane" way of killing or disabling an enemy, we will let this subject drop.

But there just isn't any such method. War itself is inhumane, all of its weapons are inhumane. Any suggestion to the contrary is mere quibbling, and compromise with facts. And with victory.

HAROLD B. RODIER, *Editor*

FROM YOUR NATIONAL PRESIDENT

At the recent Directors Meeting in Atlantic City General Charles E. Loucks, Deputy Chief of the Chemical Corps, outlined the program of the Corps with particular reference to the problems they are facing.

As a result your Directors and Executive Committee have a much clearer insight of the major problems of an industrial nature confronting the military. This should make it much easier for us to formulate and carry out our objectives more effectively and at the same time enhance our efforts to bring the military and industry closer together.

It was pointed out most forcibly at the Directors Meeting that AFCA with its many technically trained reserve officers who have both military and industrial experience, was in the best position of any organization to offer a program that would be acceptable both to the military and industry for recruitment and assignment of the scarce categories of technically trained personnel. I was asked to appoint a committee to look into this matter and make definite recommendations. This will be done. In the meantime I will be glad to get any suggestions that you may have that can be passed on to this committee for its report on this vital problem.

—L. W. MUNCHMEYER

Preparedness Pays

World War II ended with Germany and Japan having a total of more than a quarter of a million of tons of poison gas in storage. Neither had used the gas, however, probably because both were aware of this country's preparedness to wage a stronger chemical war, both offensively and defensively, Army Chemical Corps officials point out.

Death Rate

United States troops in World War I suffered more than 70,000 casualties by poison gas, slightly more than 31 per cent of our total casualties. Of these casualties, only two per cent died, as against a death rate of 25 per cent among those wounded by shells, shrapnel or bullets, Major General E. F. Bullene, Army Chief Chemical Officer, said in a recent speech.

Gas Bombs Not Used

Oddly enough, neither Germany nor the Allies ever used aircraft to dispense poison gas in World War I, Army Chemical Corps historians point out. Both sides used gas freely, and both sides used planes to drop smoke and incendiary bombs, yet neither dropped nor even fully developed a gas bomb.

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THE CHEMICAL CORPS IN ALASKA

By
LT. COL. CLAUDE W. WHITE* and CAPT. EUGENE E. MONK

YOUR EDITOR asked for an article on the Chemical Corps' activities in the Alaska Command. However, Colonel White, Alaska Command Chemical Officer, and his assistant, Captain Monk, went us one better. They've written a good story on why anyone, civilian or military, should make a tour of Alaska. The following article is an outstanding "selling job" on Alaska, and the JOURNAL is happy to be able to print it.

Alaska, to most persons who have never visited it, means a desolate, barren, permanently frozen, uninhabited wasteland far to the north. They would never dream of it as a place to live or visit.

The territory of Alaska is a subdivision of the United States like any of the states or territories. It is strictly American in language, customs, religion, and politics. Service in Alaska, therefore, is not much different from service in any of the states, except that foreign service credit is given for service in the territory.

PURCHASE OF ALASKA

Alaska was purchased from Russia in 1867 for $7,200,000 and became a territory in 1921. For many years the region was referred to by critics as "Seward's Folly," or "Seward's Icebox," because the land was believed to be absolutely worthless. From almost any standpoint the decision to purchase Alaska has proved to be wise. Exports of fish, gold, and furs alone have repaid its purchase price many times over, and the land is rich in untapped resources which were recently estimated to be of a value far exceeding the national debt. The production of gold alone has amounted to about $660,000,000.

ALASKA IS LARGE

Comparatively speaking, Alaska is large and distances are great. If a map of Alaska were placed on a map of the United States of equal scale, and if the southern tip of the panhandle of Alaska were placed at Savannah, Georgia, the island of Attu, the westernmost point of the Aleutian Chain, would fall in the vicinity of Los Angeles, California. Point Barrow, Alaska's most northern inhabited point, would fall on the border between Minnesota and Manitoba in Canada, and Anchorage, Alaska's largest city, would fall in Central Missouri. Alaska has an area of 586,400 square miles which is about one-fifth the area of Continental United States. It has a common boundary with Canada of 1,500 miles, and a coastline of 33,000 miles, including coastlines of all the islands.

POPULATION

The majority of Alaska's population, estimated by the Alaska Development Board, to be 153,900 as of 1 January 1952, is found in the cities of Anchorage, Juneau, Ketchikan, Fairbanks, Nome, Palmer, Seward, and Kodiak. There are also many small villages spread over Alaska.

TRANSPORTATION

There are three means of transportation to Alaska: overland (by the Alaska Highway); air (by Military Air Transport Service and Commercial Aircraft); and sea (by Military Sea Transport Service and Commercial Ships). Most military personnel and dependents come to Alaska aboard Military Sea Transport vessels landing at the Port of Whittier, or commercial steamship lines landing at the Port of Seward.

It has been said that Alaska was made to fly over. This feeling is borne out by the inaccessibility of many locations in Alaska except by air.

The number of privately owned airplanes per capita in Alaska is estimated by the Civil Aeronautic Administration to be one aircraft per 150 individuals which is the highest in the world. Approximately 10% of all active seaplanes of U. S. registry are located in Alaska, most of which are in the Anchorage area. There are many bush pilots who will take persons any place they want to go in Alaska at nominal rates.

* Chemical officer, U. S. Army, Alaska

For several years Merrill Field at Anchorage was the second busiest airport in the world in number of aircraft arrivals and departures, exceeded only by La Guardia Field in New York.

Three major scheduled airlines and several non-scheduled airlines operate between the states and Alaska as well as between points in Alaska. In addition, there are numerous small airlines operating within the territory.

Military Air Transport Service is available for travel of military personnel between military installations.

The Alaska Railroad, which is owned by the U. S. Government and operated by the Department of Interior, runs from the Port of Seward through Anchorage to Fairbanks. It has branch lines to the Port of Whittier and the Matanuska Valley, agricultural center of Alaska. Passenger service is available from Anchorage to Fairbanks, Seward and Whittier in modern streamlined coaches.

Highways in Alaska are relatively few. The most important are the Alaska Highway, the Richardson Highway, the Glen Highway, the Steese Highway, and the Seward Highway. A road from McKinley National Park to the Richardson Highway is currently under construction and should be completed in 1953. Some portions of this highway system have been surfaced with "blacktop," however, a greater portion is still gravel surface. Most of these highways would at best be classified as second-class country roads in the United States. They are extremely difficult to maintain under heavy traffic and difficult to keep open during the winter.

The Alaska Highway, sole land link with Canada and the United States, was constructed by the U. S. Army during World War II. It would be the life-line to Alaska in the event water and air transport were denied or curtailed. The Alaska Highway is the key to the Alaska Highway system from which all others stem.

STRATEGIC IMPORTANCE

Alaska has long been a frontier land that has captured the imagination of the pioneers and empire-builders who found great opportunity in the vast territory. Today it has assumed even greater importance as a strategic military location, providing a defensive base for the protection of Western Canada and Western United States or an offensive base for an attack against Asia.

The Alaskan mainland is separated from Northeastern Siberia by only 58 miles across the Bering Strait. Halfway across the Bering Strait, Little Diomede Island, belonging to the United States is only 2 miles from Big Diomede, belonging to USSR.

Alaska dominates the Great Circle routes in the North Pacific between North America and Asia. The Great Circle between Seattle and Tokyo passes approximately through Dutch Harbor in the Aleutians. The shortest route between Washington, D. C., and Tokyo passes through the Northern part of the Alaskan Mainland. As a matter of further interest, Great Circle routes from the geographical center of the United States to Manila and Singapore pass through Alaska in the vicinity of Fairbanks and Anchorage, respectively. Alaska thus provides important refueling or resupply stops for aircraft on these long flights.

The absence of land in the North Pacific area just south of Alaska further increases its strategic importance as an area for the location of air and naval bases. Forces operating from such bases are in a position to attack the flank of an enemy attempting to move across the North Pacific.

Alaska is centrally located with respect to almost all strategic areas in the Northern Hemisphere. Moscow, London, and Paris are only slightly more than 4,000 miles from Fairbanks. All of the United States, most of Mexico, all of Japan, a great portion of Siberia and Northern Europe are within 4,000 miles of Fairbanks.

MILITARY IN ALASKA

Since early days the U. S. Army has been closely related to Alaska. For many years it represented law and order in the pioneer land. Surveys and explorations were carried out by the Army, leading to the establishment and maintenance of telegraph and cable communications. Communication is still furnished to and within the territory by the Alaska Communications System, a Signal Corps agency, directly under the Chief Signal Officer.

In World War II, airbases in Alaska provided a direct route to Asia for lend-lease materials. An invasion of the Aleutian Islands by Japanese forces focused world attention on the strategic northland, resulting in a campaign which ended with the recapture of Attu and Kiska by American troops.

It was without doubt the growing strategic importance of Alaska that influenced the Department of Defense to establish the Alaskan Command in 1947.

The Alaskan Command is a joint command which is headed by Lt. General William E. Kepner, USAF. The Command-

er-in-Chief, Alaska, (CinCAL) as he is called, with his integrated staff of Army, Navy, and Air Force personnel, exercises operational control over the United States Army, Alaska, (USARAL) commanded by Major General William M. Miley, USA; the Alaskan Sea Frontier (ALSEAFRON) commanded by Rear Admiral John Perry, USN, who is also Deputy Commander-in-chief, Alaska; and the Alaskan Air Command, (AAC) commanded by Major General William D. Old, USAF.

The Alaskan Command has no Chemical officer on the joint staff. This results in the joint staff relying almost entirely on the Chemical Officer, USARAL, for assistance on matters pertaining to Chemical Corps activities. So far, this arrangement has worked to the satisfaction of all concerned.

The U. S. Army, Alaska, with its headquarters at Elmendorf AFB (near Anchorage, Alaska) is the Army headquarters for all army units stationed in Alaska.

Among the Army's missions in Alaska is the ground defense of air bases, port facilities and land lines of communication. Major installations at which Army troops serve in Alaska include Fort Richardson, Big Delta, Port of Whittier, and Elmendorf, Eielson, and Ladd Air Force Bases.

In addition to the ground defense mission, the Army is charged with providing theater-level logistic support for both the Army and Air Force in Alaska. Army facilities are also devoted to Arctic training and cold weather research and experiments.

CHEMICAL ACTIVITIES

The Chemical officer, USARAL, functions as any Army Chemical Officer. Close liaison is maintained with the Alaskan Command and the Alaskan Air Command. This chemical section, with generous assistance from the Alaskan Air Command, Chemical personnel of the Alaska General Depot and Fort Richardson, periodically conducts a Chemical, Biological, and Radiological Defense course. This course trains unit Chemical Defense personnel for both Army and Air Force units. During early 1952, the section conducted a series of courses to qualify personnel in Infantry and Engineer units of the command as Portable Flamethrower Gunners.

The Chemical Supply Section, Alaska General Depot, with a Chemical Service Organization and Laboratory attached, functions similarly to the supply section of a General Depot in the Zone of Interior. Army and Air Force units in Alaska are supplied through the various air bases and stations in the command.

The Chemical Supply Section, Alaska General Depot, in addition to supplying army units, supports Air Force units with Chemical class II and IV supplies except for chemical vehicles. All field and depot maintenance on chemical items is performed by the Alaska General Depot.

Fort Richardson, the largest army post in Alaska, and army units, and also Ladd Air Force Base, are authorized Chemical Corps officers as station chemical officers with sections to aid them in carrying out their training and supply missions. Other stations are authorized small chemical sections consisting of enlisted personnel only, with officers from other technical services being assigned additional duty as Chemical Supply Officer.

STORAGE

Because of the severe weather in Alaska, especially during the winter months, storage of supplies poses an unusual problem. However, with the completion of new construction at all stations, the storage problem is becoming less complex. A variety of all types of storage is currently utilized for storage of chemical items, including the mobilization type warehouse, igloo, outside concrete pads under tarpaulin, the standard stack on cleared ground under tarpaulin, and a variety of improvised structures.

MAINTENANCE

In the past, maintenance has suffered due to lack of adequate shop space. A new maintenance shop is scheduled for completion this year, making chemical maintenance an all-year operation rather than a fair weather operation as it has been in the past.

LABORATORY

The Chemical Laboratory, presently housed in quonsets, has been able to function properly except for short periods when water lines or sewers have frozen. In addition to its regular mission, the laboratory gives material support to Federal and Military law enforcement agencies, since it is the only chemical laboratory in the territory capable of performing this type of work. Close liaison is maintained with the Territorial Public Health Laboratory. The chemical laboratory is scheduled to occupy a part of the maintenance shop when it is completed.

COLD WEATHER OPERATION

With the increased emphasis on cold weather operations, Alaska is assuming an important role as a proving ground for operation in extreme cold. These operations confront a commander with greatly increased maintenance, transportation, and logistics problems entirely aside from individual problems confronting troops due to extreme cold and the great amount of time and material required for mere survival of personnel. During outdoor operations the "wind chill factor" must be constantly borne in mind. This factor is a number related to the product of temperature and wind speed. It represents the actual cooling effect on a person of a cold temperature combined with wind, since it is well known that a person will freeze more quickly on a cold windy day than on a cold still day.

Although the number of chemical assignments in Alaska at present is small, the Chemical Corps has the opportunity to build up a small reserve of personnel who have knowledge of cold weather operations from actual experience.

WEATHER

Alaska is sometimes called "The Land of the Midnight Sun." This expression has its origin in the periods during

the summer months when the sun never sets in Northern Alaska. Hours of daylight in the vast territory vary greatly from long periods of no daylight to long periods of no darkness in the North.

Although there is a wide variation in temperature, precipitation and wind over Alaska, the climate can be classified into two basic types—continental and maritime.

The continental type, found over the interior and Arctic Slope region, is characterized by great extremes of temperature. The annual range may be as much as 176°F as illustrated by absolute maximum summer temperature of 100°F and absolute minimum winter temperature of minus 76°F—both recorded at Fort Yukon. Precipitation is light, averaging 10 inches of rain and 50 inches of snow annually. Gale force winds are rare.

The maritime type, found along the coast of the Gulf of Alaska, has much smaller extremes of temperatures. Adak Island, typical of the maritime climate, has recorded an all-time minimum temperature of 12°F and a maximum of 80°F —giving a range of 68°F as contrasted with the 176°F range at Fort Yukon in the interior. Precipitation averages 60 inches of rain and 50 inches of snow annually. In the summer there is widespread fog, and in winter, storms are frequent. The area is notorious for its winds of gale force and stronger.

Exemplifying local peculiarities, snow fall at the Port of Whittier on the Gulf Coast averages 40 feet annually, roughly 10 times that of surrounding areas 100 miles away. At Big Delta in the interior, gale force winds are not unusual.

Of particular interest to the great majority of Chemical Corps personnel who might be assigned to Alaska, is the weather in the Anchorage and Fairbanks areas. In Anchorage, sometimes referred to as the "Banana Belt," the temperature extremes are 84°F absolute maximum and minus 43°F absolute minimum, with an average of 16 inches of rain and 55 inches of snow annually, while in Fairbanks, the absolute maximum is 92°F and the absolute minimum is minus 62°F, with an average 13 inches of rain and 48 inches of snow annually.

Also of interest is that the weather in the Anchorage area is less severe than that found in portions of the continental United States.

DEPENDENT HOUSING

At the four principal military installations (Fort Richardson and Eielson, Elmendorf, and Ladd Air Force Bases) government quarters are available for dependents.

These quarters are similar to those that are found at most of the military installations in the states and are assigned on the basis of date of departure from the Zone of Interior. Housing for dependents at the Port of Whittier and Big Delta is limited at present. Upon completion of the current construction season the dependent housing situation will be improved materially.

In Anchorage and Fairbanks rental housing is available, but sometimes it is difficult to find and is always at a premium price. Many military personnel have purchased housing at premium prices—in comparison with stateside prices—in the Anchorage and Fairbanks area in order to have their families with them. Numerous military personnel have bought trailers in which they live comfortably even during the winter.

FOOD

Commissaries are available at all installations. These carry good lines of staples, but are usually short of perishables.

Since practically all the perishable food consumed in Alaska is flown in, the prices on such items in the city groceries run very high. During the summer months some relief from the shortage is made up by locally-grown produce, but the prices are still high.

Although the growing season in Alaska is short, the long periods of sunlight during the summer months cause produce to approach giant size. A fact little known outside the territory is that record-size vegetables are grown at Circle Hot Springs, approximately 75 miles south of the Arctic Circle. A wide variety of produce is grown in the Matanuska River Valley, the Tanana River Valley and on the Kenai Peninsula.

To partially compensate for the high prices in the territory, military personnel are authorized additional rental and subsistence allowances.

SCHOOLS

The territory operates schools on all of the military installations for dependents. These schools rate with the best in the states. Modern school facilities are being completed at the principal installations for occupancy this fall.

TROOP HOUSING

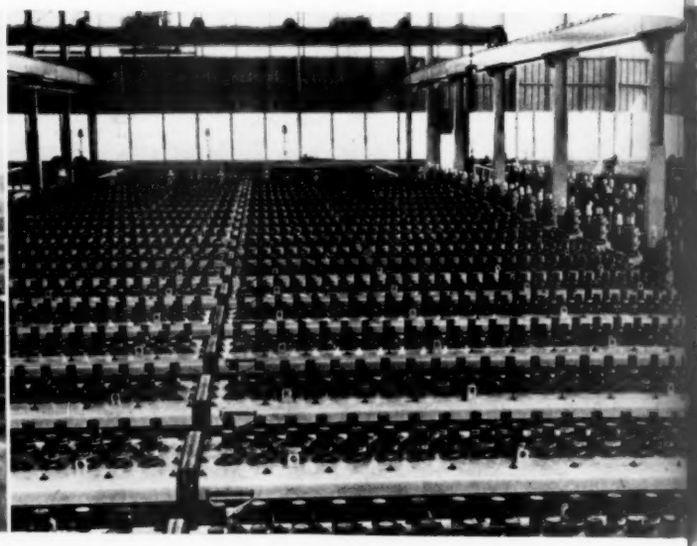
Most of the troops at Eielson, Elmendorf, and Ladd Air Force Bases and Fort Richardson are housed in permanent-type concrete barracks of 200, 500 and 750 man capacity. However, some troops are still housed in temporary structures. Troops at installations other than these are presently housed in temporary structures, but upon completion of planned construction of permanent barracks most of the troops in Alaska will be housed in permanent structures.

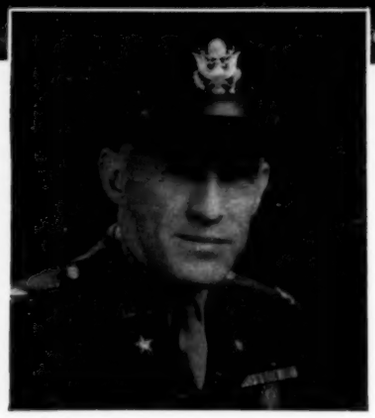
RECREATION

There are many opportunities for recreational activities available to the serviceman stationed in Alaska. For instance, during the spring and summer, when the days are long, there is swimming, hunting, fishing, mountain climbing, hiking, camping, picnics, prospecting, exploring, sightseeing, and photography. During the fall and winter there is big game hunting, including moose, caribou, bear, and mountain sheep; and

(Continued on page 53)

EXPLOITATION OF GERMAN CHEMICAL





By L. WILSON GREENE

Technical Director

Chemical Corps Chemical & Radiological Laboratories

Army Chemical Center, Maryland

After the defeat of Germany in World War II, Allied intelligence teams combed the plants and laboratories of German industry for information on processes, trade secrets, and the results of years of research and technological development. Specialists in the various scientific and industrial fields visited plants and laboratories and interrogated German chemists, engineers, and industrialists; reporting their findings in a large number of documents which have been made available to American industry. In addition, original German research and production records were copied on microfilm by Allied investigators.

The U. S. Department of Commerce established the Office of Technical Services to collect, catalog, reproduce, and distribute reports on all phases of German technology on a nonprofit basis. Private organizations have translated hundreds of significant German industrial documents which can be purchased at reasonable prices. Individual members of the intelligence teams and others have published summaries and critical reviews of the information thus obtained. After the war I compiled "The German Chemical Industry. A Bibliography of the Chemical, Metallurgical, and Process Industries," where references to sources of this information may be found. This book was published in 1950 by the Department of Commerce, and was reprinted in 1951 to meet the demand for additional copies (1).

From the foregoing, it will be seen that every effort has been made to provide easy access to the information which was obtained on German chemical technology.

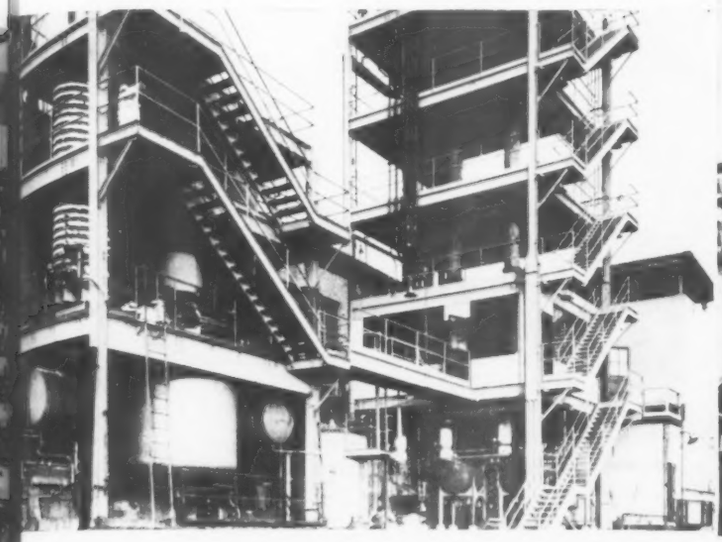
What use has American industry made of this information in the seven years that have elapsed since the war?

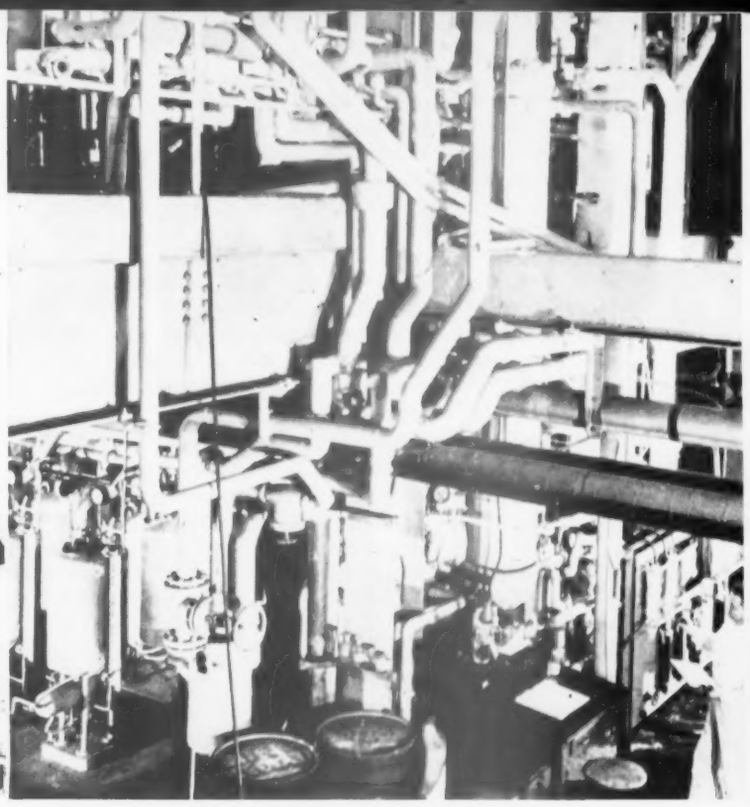
To answer this question, I wrote letters to a large number of firms representing a cross-section of the chemical, metallurgical, and process industries throughout the United States. The concerns covered by this survey manufacture a wide variety of products, including inorganic and organic chemicals, pharmaceuticals, dyes, plastics, wetting agents, petroleum derivatives, synthetic resins and plastics, synthetic fibers, rubber, food products, soaps and detergents, ceramics, abrasives, metallurgical products, etc. Each firm was asked if it had exploited the German data and, if so, to furnish information on any processes employed and plants erected for the purpose.

Of the 109 firms replying to the inquiry, only 15 stated that they had used the German information to develop new products or processes. Eighteen firms did not reply. A few manufacturers said that the information had been helpful, but the remainder advised that they either had not made any use of the data or that the information had been studied merely as a check against what they were already doing.

It may be interesting to quote directly from some of the letters I received.

E. I. du Pont de Nemours & Company: Dr. W. E. Lawson, Immediate Past President of the Armed Forces Chemical Association, writing from the Development Department of this firm stated, "Inquiry from different departments has uncovered no reaction or process in which data obtained in our surveys of German industry has been of assistance. Minor variations in processes but no important changes have been





made. So far as I can learn, no plants have been built and no processes have been installed in which information from Germany was a dominant factor. In some cases we have based research on ideas gained from the published data from these German surveys, but I consider this in the same class as research initiated as a result of reading a thought-provoking article in the JOURNAL OF THE AMERICAN CHEMICAL SOCIETY."

Rohm & Haas Company: "We do not have any industrial process in operation which is based on technical information obtained from the German data collected by the postwar teams in Germany. We have, of course, benefitted in research as a result of the ideas contained in these reports and it is possible that some of our later products and processes were stimulated by the German work. Even though we are doing some things which were not directly reported from Germany, the ideas obtained from this may be considered as the parents of some of the things we have done."

Advance Solvents & Chemical Corporation: "We have not exploited any of the data. We might add that in some cases where we were interested we found that the data was insufficient and in some instances we could not obtain the results given in the technical data."

Mallinckrodt Chemical Works: "We have followed the reports dealing with the German chemical processes with much interest and many of them have been acquired on microfilm for our library. While this information has been helpful to us on several occasions, we do not operate any of the foreign processes in our plants."

Mutual Chemical Company of America: "Although we have neither built new plants nor installed processes based on the information in these reports, they have contributed something to our general knowledge, and as a valuable source of technical information, we have made frequent use of them."

Allied Chemical & Dye Corporation: "There can be no question that the technical information made available to the American chemical industry through the efforts and efficiency of those who went to Germany after the end of World War II for the purpose of obtaining such information added greatly to the general knowledge in this country and has been of substantial value to the industry. However, in many instances the matter of identifying and segregating such data from data already available, or which was otherwise obtained or developed, and determining the use thereof in (our) plants and processes, would be very difficult."

The American Agricultural Chemical Company: "We did have a number of the German developments, studied these very carefully, but never exploited any of the material. We were particularly interested in the red phosphorus process but decided against any change from our present methods of production."

Stauffer Chemical Company: "Our Company has not exploited any of the German technical data which were made available through BIOS (British Intelligence Objectives Sub-Committee), FIAT (Field Information Agency, Technical), and similar reports. We obtained a large number of these reports and scanned the indices for every topic of interest. However, all the data we got fell into one of the following categories: (1) the German process was not new to us, (2) it was new, but not technically superior to our present process, (3) it was new, but not economic except under conditions peculiar to Germany. I attribute this small return to the fact that ours is a heavy chemical company, in which advances in chemistry are very few and far between. Our problems are more often of a chemical engineering nature, and from what we have seen, American chemical engineers are years ahead of those in Germany, or for that matter, in Europe."

Monsanto Chemical Company: "We naturally are familiar with the information in our areas of activities in these reports, and have considered it along with other published literature as a source of general information. We had, of course, cooperated with the teams that were sent to Germany to develop the information which is covered in these government publications. In the fields of our activity, we found some duplication of interests in research and process developments. However, we have not built plants nor developed processes based to any great extent on the information . . . without very substantially adding to it our own research and engineering developments and experience. It would be difficult to say that we have not found that this published information regarding the German chemical industry did not play any part in stimulating the thinking of our chemists and engineers, which did and may in the future eventuate in plant operations to produce materials by processes analogous to those mentioned in these reports. However, in the instances

where plants have been erected, almost without exception we were working in these fields and were active on processes for these materials before the published information on German developments was available. Summarized, we might say that these reports provided another source of general information, but we have not based specific operations on the detailed data they covered. It might also be mentioned that contrary to the position in other Allied countries, many of the disclosed German developments are still covered by patents issued to an American company and these developments are therefore not freely available to use without obtaining a license, as provided by the Alien Property Custodian."

Union Carbide and Carbon Corporation: "Our various laboratories have not attempted to duplicate German technology of war years in view of the rather significant economic differences existing between a war economy and the civilian economy in this country. We have, however, considered that the many valuable publications which have come to us through various sources constitute an important addition to the pool of pure science available for industrial application. Without great effort, it would be almost impossible for us to differentiate between ideas which came to us through German sources of the war period and those which are available in the technical literature generally. We have long followed the practice of utilizing pure science information in developing industrial applications of science and without question, many building blocks of projects under current investigation will be of wartime German origin."

Wyandotte Chemicals Corporation: "At the present time there are no products manufactured at Wyandotte that directly employ processes or methods of manufacture introduced from Germany. However, the vast amount of information made available in chemical and related fields has been of great assistance in judging the economic aspects of new products and a guide to the possible application of new products."

Jefferson Chemical Company, Inc.: "The only products we manufacture commercially at the present time are ethylene oxide and ethylene glycol, and the coproducts obtained in carrying out this process through the chlorohydrination route. At the time the information from Germany became available, our pilot plant work and plant design were already well under way. No material changes were made in the design on the basis of the German data and the plant bears very little, if any, resemblance to any used by the Germans for the production of similar products. The German data did, however, serve to confirm some of the conclusions which we had reached in our own development work."

The Texas Company: "We have given careful study to those portions of the technical information applicable to the petroleum industry and obtained from Germany at the end of the war. It is certainly true that this information has been valuable in supplementing and confirming data available from our own research work and commercial operations. It is not, however, possible for us to cite specific commercial developments which could be said to have resulted directly from the German developments."

Shell Development Company: "Many of the processes originating in Germany have, of course, been considered by our engineers in the usual economic comparison of alternative methods, but in no case have we chosen any of them."

United States Rubber Company: "The technical information on synthetic rubber brought over to the United States from Germany after the end of the war, was polled by the government and made available to the entire rubber industry. Examination of the German records revealed that many of the ideas and processes developed in Germany during the war closely paralleled those of the rubber industry in this country. Due to the similarity of developments in both countries, it is difficult to say just what specific benefits we received from the Germans. Much of the German technical data was still in the theoretical phase of development or in laboratory stage. The American rubber industry was first to put synthetic rubber into large-scale production and to improve its quality to a point where it could compete with natural rubber for satisfactory performance in a wide range of products."

Ferro Corporation: "Although much technical data related to the ceramic field primarily has been studied by this organization, we have made no direct industrial use thereof. We may say that the principal benefit derived from the information reviewed, has been that it has served as a source of ideas for initiating new development and research studies. For the most part, the information reviewed by us was reported as being rather obsolete."

Johns-Manville Corporation: "After the war we made a very careful study of German technical data even sending a man to Germany to explore this matter first-hand. However, we have not found any of this information which we could use in our business."

Now let's turn to the applications that have been made of the German technical information.

INORGANIC AND ORGANIC CHEMICALS

The most widely publicized use of a German development was the installation of the modified Mercury chlorine and caustic cell by **The Dow Chemical Company** at its Sarnia plant (Dow Chemical of Canada, Limited). A description of the plant was published in this JOURNAL by Colonel Harry Kuhn, past President of the Association, in 1949 (2). Since that time the capacity of the plant has been doubled by the addition of more cells. One view of the cell room is shown in Figure 1.

Both the **Columbia-Southern Chemical Corporation** (subsidiary of **Pittsburgh Plate Glass Company**) and the **Westvaco Chemical Division of Food Machinery and Chemical Corporation** studied the German mercury cell but neither concern has yet adopted this method for producing chlorine and caustic soda.

Buffalo Electro-Chemical Company, Inc. has not utilized the German process for making concentrated ("high-test") hydrogen peroxide. They are convinced that they were much farther advanced than the Germans in this field. They obtained intangible benefits from the German data, mostly in the nature of verifying the development information they had already acquired from their own work.

The Davison Chemical Corporation manufactures an oxidation catalyst for converting naphthalene to phthalic anhydride. The catalyst is a silica gel impregnated with vanadium oxide and potassium sulfate and gives 95 per cent of the theoretical yield of phthalic anhydride. The development of the catalyst was based on German technology as disclosed by FIAT and BIOS reports. The preparation and use of the catalyst is described in an article by Hathaway and Myrick, published in 1949 (3).

The manufacture of chlorobromomethane was investigated by the **Michigan Chemical Corporation.** This compound was manufactured in Germany during the war for use as a liquid fire-extinguishing agent mainly for military aircraft engines in fixed installations. The German physical, toxicological, and application data were found to be quite useful, but the production method proved to be impractical from an economic stand-point. Michigan Chemical subsequently developed their own manufacturing process and is now producing the fire-extinguishing fluid for the U. S. Air Force and for civilian use.

The **General Aniline Works of General Aniline & Film Corporation** advised that, "Investigation at the Brasselli and Rensselaer Plants of this Division reveals that assistance received from German chemical process information is probably less extensive than that of the average U. S. company as much of our manufacturing information had I. G. origin and, therefore, considerable knowledge already existed in our files."

The most important developments at General Aniline resulting from pioneering work in Germany are concerned with the manufacture of the synthetic substitute for blood plasma, polyvinylpyrollidone (PVP), a derivative of acetylene, and pilot plant exploitation of the high-pressure acetylene reactions developed in Germany by Dr. J. Walter Reppe of I. G. Farben's Ludwigshafen plant.

Enough PVP powder is produced by General Aniline each month to make well over a million pints of solution of blood plasma substitute. It is emphasized that PVP is not a substitute for whole blood and does not reduce the need for blood donations, but it does serve as a readily available, inexpensive, and easily administered treatment for shock cases. An article entitled, "PVP—the Plastic Plasma" appeared in Reader's Digest for August 1951. Figures 2 and 3 show views of the PVP plant at Graselli. (See article on PVP, page 24.)

Two pictures of General Aniline's new acetylene products pilot plant are shown in Figures 4 and 5. Those interested in the so-called "Reppe Chemistry" are referred to the monograph written by Copenhaver and Bigelow in 1949 (4).

There was one instance where information obtained from a BIOS report assisted in the development of an improved process for manufacturing Fast Violet B Base. This resulted in considerable manufacturing economies since the nitration was carried out in an aqueous medium into the German process, instead of in glacial acetic acid as formerly by General Aniline. A higher yield of nitration product also resulted.

Another improvement learned from the wartime reports concerned the synthesis of carboxyphenylgamma acid. They formerly started with gamma acid but changed over to the German method which starts with 2, 8-dihydroxynaphtholene-6-sulfonic acid.

Air Reduction Company, Inc. has carried out considerable laboratory work with the Reppe reactions involving acetylene.

Information on vinyl chloride, monochlorobenzene, and para-dichlorobenzene was evaluated by the **Columbia-Southern Chemical Corporation,** and **Western Chemical** studied benzene hexachloride, hexaethyl tetraphosphate, tetraethyl pyrophosphate, and other products.

In the manufacture of ethylenediamine tetraacetic acid, **Alrose Chemical Company** made use of some of the German process data available on the corresponding I. G. Farben product, Frilon B. Much of the information existed in the American patent literature, however, Alrose Chemical believe that they are the only manufacturer in the United States using a modification of the German process to produce materials of very high purity. They market their product under the trade name "Sequestrene."

Colgate-Palmolive-Peet Company has employed fluorescent dyes or brighteners in soaps and detergents, using the German materials known as "Blankophors." The firm has also used carboxymethyl cellulose ("Tylose") in synthetic detergents.

CHEMICALS DERIVED FROM PETROLEUM AND COAL

Standard Oil Company (Indiana) has conducted extensive research and development work on the oxo reaction (worked out in Germany), which is the catalytic addition of carbon monoxide and hydrogen to an olefin to produce aldehydes. Usually these aldehydes are reduced with hydrogen to primary alcohols in the second stage of the process. A continuous process for the production of alcohols has been developed, and a plant for the production of nonyl alcohol by this procedure is planned for erection at the Whiting refinery. High-boiling noyl esters are useful as plasticizers for vinyl and other synthetic esters.

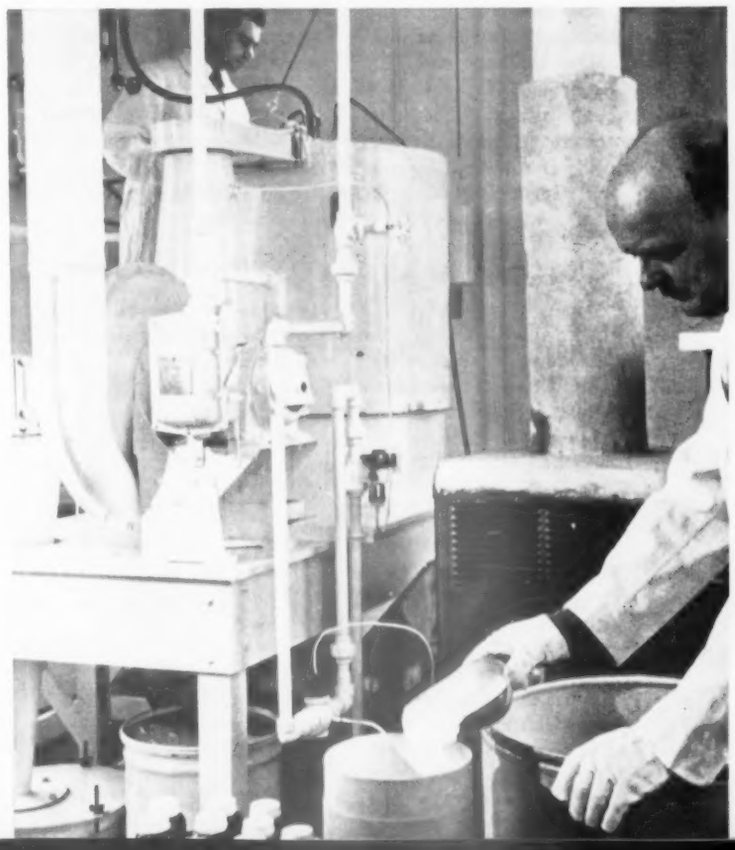
The Standard Oil Development Company wrote, "After the last war we, along with many others, studied the large amount of technical information that became available . . . It was our general experience that while the German data may have added somewhat to our general fund of basic chemical knowledge, we did not find anything that was suitable for exploitation by us. As you know, the Germans had concentrated on the commercial development of hydrogenation and the Fischer-Tropsch process and neglected research work to a considerable extent during the war period. For example, on the hydrocarbon synthesis process, which we worked on after the war, we worked along radically different lines than those followed by the Germans since we felt that the German embodiment of the process was quite expensive in plant cost and in operating cost. On the hydrogenation process, the Bureau of Mines has studied the German data and has followed it to a considerable extent in their work."

The Bureau of Mines demonstration plant for the Fischer-Tropsch process (selective catalytic hydrogenation of carbon monoxide) was erected at Louisiana, Missouri by the **Koppers Engineering and Construction Division** of **Koppers Company, Inc.** The company advised that a considerable number of refinements over the German plant were incorporated. An extensive and critical review of reports of German work on the Fischer-Tropsch and related syntheses was published by Storch, Golumbic, and Anderson (5).

PHARMACEUTICALS

Two pharmaceutical products are being manufactured by **Eli Lilly and Company** as a direct result of visits to Germany by technical personnel after the war. One of these is called Amidon (sold under the name of Methadon in this country) by the Germans and is being marketed by Lilly under the trade name "Dolophine." It is a very powerful analgesic and resembles morphine somewhat in its action. Hence the compound comes under the jurisdiction of the Federal Narcotics Bureau. The other product is Aludrine, which possesses some of the effect of Ephedrine.

Abbott Laboratories is also producing "Amidon," based on the German process. Likewise they are making Aludrine which they call "Norisodrine." They have offered Norisodrine Sulfate for oral inhalation in a special cartridge. The drug is used for treatment of asthmatic attacks and other bronchial spasms. Abbott Laboratories were not successful in their attempts to make III-nitro-IV-hydroxyphenyl arsenic acid by the German method.



METALLURGY

Of the five smelting, refining, and metal processing firms which were approached, only one has made use of German technology. The **Aluminum Company of America** reports, "The following are probably the most important items from the standpoint of Alcoa and the aluminum industry:

"The very large forging presses; we are now installing a 15,000 ton German forging press at our Cleveland works. The knowledge of this was not new, as there were slightly larger forging presses than that in this country. We were, however, impressed by the extent to which the Germans heated forging dies so as to get the thin portions of certain forgings down to smaller dimensions.

"Germany has gone on to larger extrusion presses than were used in this country. The largest ones in this country were about 5,500 tons. The Germans had built some to 12,000 tons. We are now going to larger extrusion presses in this country, and I believe the German experience accelerated that program over here.

"The equipment designed by the Germans for the measurement of large amounts of direct current; this is what might be called a 'DC Transformer,' and takes the place of the shunt and millivoltmeter ordinarily employed for measuring such currents. This sort of equipment is now in use in one or two of the newer aluminum plants. This is much cheaper and requires less power than the shunt equipment. Our technical people were able to interest the Westinghouse Company in making the new equipment, and they have called it a 'Current Transductor.' They describe and illustrate the device on page 125 of the March 1950 issue of **Westinghouse Engineer.**

"Our research people are experimenting with a scheme observed in one of the German aluminum reduction potrooms, where several of the ordinary carbon anodes were connected together on a short busbar and hung as a group from the anode bus with a single connecting strap."

CONCLUSION

While the survey reported here does not represent a complete coverage of American industry, a sufficient number of firms manufacturing a large variety of products have been interrogated to justify the following conclusion: There has been no widespread adoption of German processes by the American chemical industry. The instances where German technical information has been applied are the exception rather than the rule. The explanation for this seems obvious; American research and engineering ability has for years been on a par with, and in many cases superior to, German accomplishments in this field. This fact should dispel the illusion still held by a large segment of the American public that German chemical technology has always been far ahead of the rest of the world.

ACKNOWLEDGMENTS

The Armed Forces Chemical Association and I wish to thank the following firms who have so kindly furnished information for the preparation of this survey:

Abbott Laboratories
Advance Solvents & Chemical Corporation
Air Reduction Company, Incorporated
Allied Chemical & Dye Corporation
Alrose Chemical Co.
Aluminum Company of America
The American Agricultural Chemical Company
American Bio-Synthetics Corp.
American Colloid Company
American Cyanamid Company
American Pharmaceutical Company
American Potash & Chemical Corporation
American Resinous Chemicals Corporation
American Smelting and Refining Company
American Viscose Corporation
American Zinc, Lead and Smelting Company
Ansul Chemical Company
Arapahoe Chemicals, Inc.
Armour and Company
Arnold, Hoffman & Co., Incorporated
Atlas Powder Company
Bakelite Company (Division of Union Carbide and Carbon Corp.)
Belle Alkali Company
Belmont Smelting & Refining Works, Inc.
Henry Bower Chemical Manufacturing Co.
Bristol-Myers Company
Buffalo Electro-Chemical Company, Inc.
Godfrey L. Cabot, Inc.
The Carborundum Company
Cities Service Oil Company
Colgate-Palmolive-Peet Company
The Colorado Fuel and Iron Corporation
Columbia-Southern Chemical Corporation (Subsidiary of Pittsburgh Plate Glass Company)
Commercial Solvents Corporation
Corn Products Sales Company
The Davison Chemical Corporation
Delta Chemical Works
Diamond Alkali Company
The Dow Chemical Company
E. I. du Pont de Nemours & Company, Incorporated
Ethyl Corporation
Ferro Corporation
The Fluor Corporation, Ltd.
Foote Mineral Company
General Aniline & Film Corporation
General Electric Company
General Mills, Inc.
The General Tire & Rubber Company
Glyco Products Co., Inc.
The Goodyear Tire & Rubber Company
Hercules Powder Company, Incorporated
Heyden Chemical Corporation
Hoffmann-LaRoche, Inc.
Hooker Electrochemical Company
Innis, Speiden & Co., Inc.
Interchemical Corporation
Jefferson Chemical Company, Inc.
Johns-Manville Corporation
Koppers Company, Inc.
Lambert Pharmacal Company
Eli Lilly and Company
McKesson & Robbins, Incorporated
Mallinckrodt Chemical Works
Marathon Corporation
Mathieson Chemical Corporation
Merck & Co., Inc.
Metal Hydrides, Incorporated
Metalloy Corporation
Michigan Chemical Corporation
Monsanto Chemical Company
Mutual Chemical Company of America
National Starch Products, Inc.
The Neville Company
Norton Company
Oliver Company, Inc. (Sole Distributors for Lamex Chemical Corporation)
Onyx Oil & Chemical Co.
Parke, Davis & Company
S. B. Penick & Company
Pennsylvania Salt Manufacturing Co.
Chas. Pfizer & Co., Inc.
Phillips Petroleum Company

(Continued on page 49)

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"AND A VOICE SHALL BE HEARD"

A Civil Defense educational film, "And A Voice Shall Be Heard," produced by the March of Time for the General ElectricCompany was shown at the last meeting of the Executive Committee of the A.F.C.A. Their purpose in viewing the film was to appraise its value to our membership as a means of arousing and stimulating interest in current Civil Defense preparatory activities. It was the opinion of the Committee that the film is thoroughly worth seeing and is capable of doing the job it was designed to do. Chapter officers are being asked to arrange to show this film at Chapter meetings. The following article will be of interest to our members, since presumably most of them will presently be given an opportunity to see the film at one of the A.F.C.A. meetings.

The General Electric Company recently released a documentary film, titled "And A Voice Shall Be Heard," which is being hailed by trade magazines as one of the most intelligent, generally useful and successful films on the subject of civil defense and atomic preparedness.

Although the film is limited to the communications aspect of civil defense activity, it has been pointed out by Federal civil defense authorities that communication is the nerve center of civil defense. Without communication, other preparedness efforts could collapse after the bombs fall.

The film has received excellent reviews in the SATURDAY REVIEW, and FILM DAILY. It has been awarded a Medal of Honor by the Freedoms Foundation of Valley Forge.

Said the SATURDAY REVIEW, "Perhaps because it is concerned with a community of people, as well as a family of individuals, it gives civil defense a positive rather than a negative connotation. Perhaps because it shows people working at tasks for the welfare of everyone, it increases a sense of protection as well as a desire to be prepared for one's own part in an emergency."

Various media which keep the American people the best informed in the world—the newspapers, radio, television, etc. —are woven into the film as it follows an average family and the community life at Syracuse, N. Y. through a typical day.

The film reaches its climax with a simulated bomb attack on Syracuse, and records the working of an emergency radio communications system used to direct rescue and other operations in the "disaster" area.

The emergency radio system shown in operation was set up by General Electric for Onondaga County, N. Y., which includes the city of Syracuse. The system is flexible to the extent that it can supplement present communications in the area when needed, or "take over" for all present facilities in the event they are sabotaged or damaged in bombing attacks. It adds radio facilities which can be used in peace as well as war emergencies.

Basically, the Onondaga County system revolves around a communications center equipped to (1) coordinate all two-way radio facilities in the area, (2) act as a standby system for all or any of these facilities if they are damaged in an emergency, and (3) tie into other methods of communication such as the public telephone system and amateur radio network.

In planning the system, first and foremost consideration was given to the maximum use of existing two-way radio facilities within the county.

Thirteen existing two-way radio systems, operated by municipal and private agencies in Onondaga County, are tied into the civil defense communication system. The 13 agencies

(Continued on page 50)

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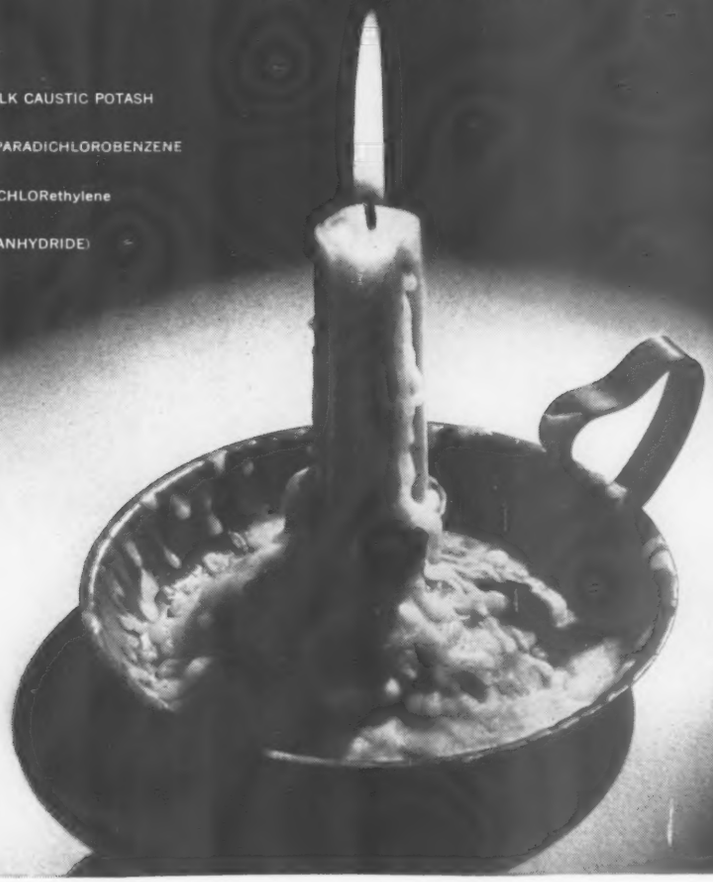


RESEARCH PROGRAM OF THE CHEMICAL CORPS MEDICAL LAB

By DAVID BRUCE DILL
Scientific Director, Chemical Corps Medical Laboratories
Army Chemical Center, Maryland

Mission

The research program of the Chemical Corps Medical Laboratories centers around basic research on the medical aspects of chemical warfare. This research is essential to the development of defensive, as well as offensive, measures. In more detail the mission is described as follows: Toxicology of chemical warfare agents; physiological, pharmacological, biochemical, and neurological research leading to improved protective and treatment measures.

It is fair to inquire, "*Why medical research in the Chemical Corps?*" This came about as a result of an informal agreement between the Army Medical Service and the Chemical Corps. Both agencies require the basic research; economy required that this be concentrated in one place. The Medical Service depends on our developing first aid and treatment measures. In line with that policy a senior medical officer is assigned to the Chemical Corps to administer the laboratory. The present commanding officer is Colonel Milward W. Bayliss.

There are four research divisions in Medical Laboratories. The first of these, the Toxicology Division, has the following mission: Evaluates the toxicity of chemical warfare agents, the adequacy of protective materiel and hazards to the health of those involved in handling toxic chemicals.

Its three component branches, which accomplish this mission, are as follows: Field Toxicology, Gassing, and Aerosol.

The Physiology Division has the following mission: Research on the physiological action of toxic chemicals with emphasis on environmental factors and on the search for drugs having antagonist action towards toxic chemicals.

Its four component branches, which accomplish this mission, are as follows: Applied Physiology, Biophysics, Entomology and Pharmacology.

The Biochemistry Division has the following mission: Biochemical Research on mechanism of action of toxic agents; relation between chemical structure and drug activity; pharmaceutical means for preventing and treating chemical casualties, and methods for detecting contaminants in food and water.

Its four component branches, which accomplish this mission, are as follows: Enzyme Chemistry, Medicinal Chemistry, Pharmaceutical Chemistry, and Sanitary Chemistry.

The Clinical Research Division has the crowning mission of Chemical Corps Medical Laboratories, as follows: Constantly seeks for greater effectiveness in treating chemical warfare casualties. Conducts research on pathological and neurological effects of toxic chemicals and of therapeutic drugs.

Its three component branches, which accomplish this mission, are as follows: Clinical Investigation, Neurology, and Pathology.

Research Staff

A research laboratory must have facilities, an administrative structure, and funds. Speaking in physiological terms these comprise the skeleton, vital organs, and metabolic resources. But these are not enough for a useful life; in evaluating an individual one considers his character, intelligence, and personality. Similarly in evaluating a research laboratory, one considers the qualifications of the scientists responsible for its program. The Chemical Corps is proud of the achievements of its research staff, and I am particularly proud of those who guide the research program of the Chemical Corps Medical Laboratories.

Our senior scientist in point of service with the Chemical Corps is Dr. S. D. Silver, Chief of Toxicology Division. Dr. Silver is our authority on toxicological assessment of CW agents. The picture, Figure 1, shows him in conference with two of his staff, Dr. F. N. Marzulli, Chief of Field Toxicology Branch, and Mr. Eugene Krackow, Chief of Aerosol Branch.

The third Branch in this Division, Gassing, is headed by Dr. Fred A. Oberst. He has a distinguished record in toxicological and biochemical research, including two years with the United States Air Force, School of Aviation Medicine, Randolph Air Force Base, Texas. The picture, Fig. 2, shows

Figure 1
Staff of the Toxicology Division

Figure 2
Personnel of the Gassing Branch Toxicology Division

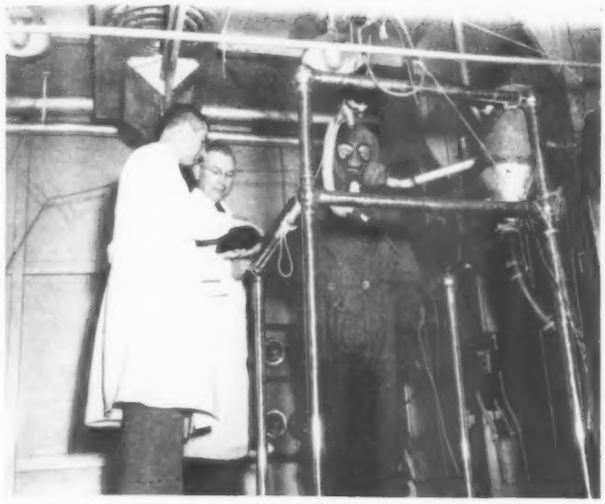


Figure 3
Personnel of the Applied Physiology Branch, Physiology Division, with Dr. Chambers, in the Tropical Test Room

Figure 4
Staff of the Entomology Branch, Physiology Division

Dr. Oberst's assistant Branch Chief, Mr. Frank McGrath, Mrs. Ethel B. Hackley, Pfc. John R. Greene, and 2nd Lieutenant John S. Hines, USAFR. Lieutenant Hines is one of several Air Force Officers on duty with the Chemical Corps. Pfc. Greene is typical of the 141 enlisted men assigned to our laboratories. He is a graduate of Wake Forest College, receiving his B.S. in Biology. His assignment is an excellent illustration of the Army policy of assigning enlisted men where their special talents and training will be utilized to best mutual advantage.

Dr. W. H. Chambers came to Medical Laboratories in 1947 from an associate professorship at Cornell Medical School and after four years' active duty in the Army as a nutrition officer. As a Colonel in the Reserve (MSC) he is active in the Baltimore research and development group of Reserve officers. The picture (Fig. 3) shows Dr. Chambers with Dr. Craig, Chief of Applied Physiology Branch, in the "hot" room. The soldier "experimenter," Pvt. Paul J. Rosendick, is trying out an experimental protective outfit in a simulated tropical environment.

The Entomology Branch of this Division is headed by Dr. Leigh E. Chadwick. He is shown with two of his staff, Mr. Byron Lovell and Lieutenant James F. Case (Figure 4). More will be said about this Branch later.

The Pharmacology Branch is headed by Dr. J. H. Wills. It happens that both Dr. Wills and Dr. Chadwick are former students of one of our country's most eminent physiologists, Dr. Wallace O. Fenn, Professor of Physiology, University of Rochester. At the moment Dr. Wills and Dr. Fred Snyder of Dr. Chadwick's staff are on a mission for the Chemical Corps in Europe. They are visiting various laboratories in England and on the continent for exchange of ideas pertinent to our research program. The picture (Fig. 5) illustrates one phase of an experiment designed to evaluate a drug proposed for treating nerve gas poisoning. Many will recognize the Warburg apparatus. The operator on the left is Mrs. Aili A. Oikemus and on the right, Mrs. Elizabeth Robinson.

The Biophysics Branch is concerned with wound ballistics problems with strong support (funds and military personnel) from the Army and Air Force Medical Services. Figure 6 shows one phase of a study of body armor behavior. In the control station of Biophysics "shoot room," Dr. F. A. Odell, Assistant Branch Chief, has just fired the gun electrically and the bullet speed is being recorded from the chronograph by 2nd Lieutenant Imogene Hill, USAFR. Dr. C. M. Herget, Branch Chief, is resetting a chronograph in readiness for the next shot. Lieutenant Milford Vaughn is computing the very precise time delay required for the next shot of the series.

The Biochemistry Division is in charge of Dr. William H. Summerson who was an associate professor of Biochemistry

Figure 5
Warburg Apparatus

Figure 6
Staff of the Biophysics Branch, Physiology Division

Figure 7
Staff of the Biochemistry Division

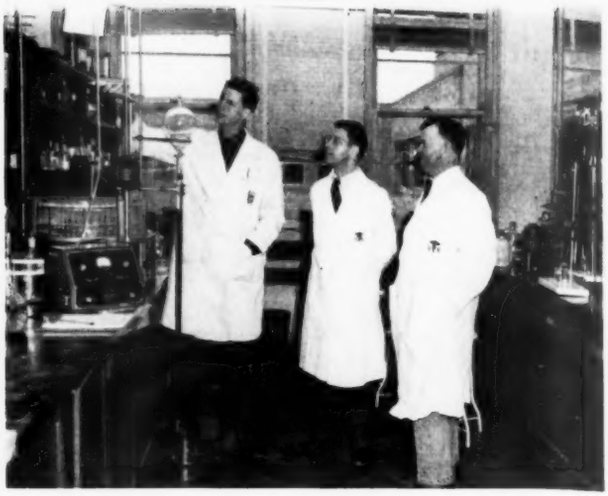


Figure 8
Staff of the Enzyme Chemistry Branch, Biochemistry Divison, with Dr. Summerson

at Cornell Medical School before he joined us in 1947. He is a faculty member of the University of Maryland, authorized to give a graduate course in biochemistry. Through this arrangement, supported by a Chemical Corps contract, many such courses are given by scientists of Medical Laboratories and Chemical and Radiological Laboratories at the Army Chemical Center. Dr. Summerson is shown in conference with two of his branch chiefs, Mr. Joseph Epstein, Sanitary Chemistry Branch, and Dr. Albert Kondritzer, Pharmaceutical Chemistry Branch (Figure 7). They are examining a kit developed in the latter branch for treatment of chemical warfare casualties.

A third branch, Enzyme Chemistry, is headed by Dr. Bernard Jandorf. His Ph.D. was obtained under Dr. A. Baird Hastings, Jr., eminent professor of Biological Chemistry, Harvard University. In the picture (Figure 8) Dr. Jandorf is discussing with Dr. Summerson and Pfc. Stephen C. May, Jr., an experiment the latter is conducting with radioactive labelled DFP. Pfc. May is a graduate of the Oglethorpe University. As a result of the recommendation given him by Dr. Summerson, based on the high quality of his research, he has been accepted by the University of Georgia Medical School.

The fourth branch, Medicinal Chemistry, is under the leadership of Dr. Wagner-Jauregg, a world renowned authority in this field. Figure 9 shows him observing Mr. Reuben Proper operating the Van Slyke apparatus. On the right Mr. Brennie Hackley is using a Warburg apparatus. Mr. Hackley is one of several junior scientists in Medical Laboratories whose introduction to Medical Laboratories was as an enlisted man. He demonstrated capacity for research and after his discharge was appointed to a civil service position. Now after three years in Medical Laboratories he is recognized as one of our promising junior investigators.

The Clinical Research Division is led by Dr. Amedeo S. Marrazzi who came to us in 1948 from Wayne Medical School where he was Professor of Pharmacology and Therapeutics, and Chairman of the Department. He is a pharmacologist and neurophysiologist with an international reputation. In addition he has a background of training in medicine and in the field of clinical investigation, having, for example, been a consultant in medicine at the Receiving Hospital of the City of Detroit. Figure 10 illustrates an experiment involving electronic recording of cortical impulses resulting from stimuli This preparation is useful in localizing the effects of nerve gases within the nervous system. Dr. Marrazzi and the Chief of the Neurology Branch, Dr. E. Ross Hart, are assisted by Dr. Mary C. Hrubetz.

The Chief of the Pathology Branch, Major James K. MacNamee, is assisted by an able staff, including several medical officers. One of these, Lieutenant Bernard Cohen, is shown

Figure 9
Staff of the Medicinal Chemistry Branch, Biochemistry Division

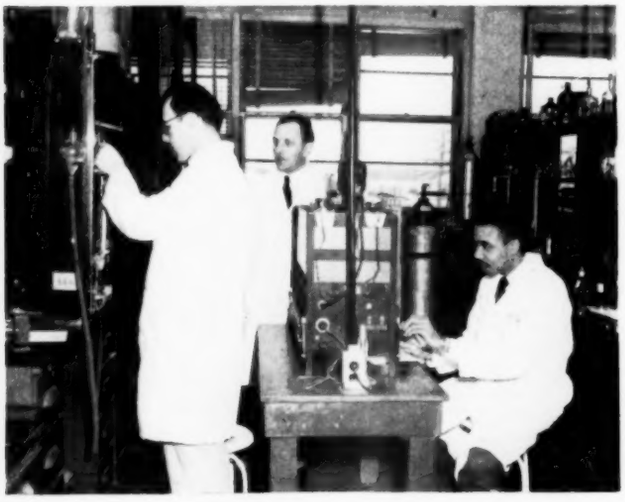


Figure 10
Staff of the Clinical Research Division

examining tissue sections from Dr. E. L. Gray, of Clinical Investigation Branch. Pfc. Francis Muscatell, an expert in determining cholinesterase activity, is on the left (Figure 11). This Branch is a meeting ground for investigators from every other branch; they come here for help in resolving many of their problems.

The Clinical Investigation Branch is in charge of Dr. Gustave Freeman. His principal assistant, Dr. John A. Clements, with the help of Captain James C. Moore, are shown in Figure 12 evaluating air-way resistance on Pvt. Joseph A. Lynott, Jr. Pvt. Lynott has a B.S. in biology from Villanova and hopes to enter medical school after his discharge. Dr. Freeman came to us from Harvard a year ago and has behind him three years of distinguished military duty with the Army Medical Service. He combines clinical skill with a keen interest in clinical investigation. His assistant branch chief, Dr. John A. Clements, was with us as a medical officer for two years and then elected to stay on in a civil service capacity. He and Captain Moore have been establishing their reputations as competent respiratory physiologists.

Besides these four research divisions with their fourteen research branches, we have a Technical Services Division, headed by Lieutenant Colonel Albert Jones, MSC, and containing three branches: Veterinary, Captain Robert D. Henthorne, Chief; Property, Mr. L. A. Williams, Chief; and Maintenance, Major W. E. Knight, Chief.

Throughout Medical Laboratories we have a faithful and efficient group of employees. I regret that space does not permit more than passing mention of what an essential role they play in the accomplishment of our mission. I single out one of them for special mention, Mr. Coy W. Crouse. He has the longest record of service with Medical Laboratories, having started work with the antecedent organization in 1929. He now holds the senior civilian position in the Veterinary Branch. He is shown looking after the rabbit colony (Figure 13).

Research Contracts

Besides the intramural research conducted by our staff, we have contractual relations with several universities, medical schools, and industrial laboratories. Examples of some university contracts now in effect are those with the Universities of Maryland, Johns Hopkins, Virginia, Florida, Harvard, Pennsylvania, Pittsburgh, Illinois, Colorado, and Utah. The National Opinion Research Center, Sterling-Winthrop Research Institute, Sharp & Dohme, Inc., and Schieffelin & Co. also contribute to this program. Because of limitations in facilities and in personnel, the staff of Chemical Corps Medical Laboratories cannot solve all of the urgent problems that confront them. Hence, the above institutions (and many others) are called upon for help. The research program of Medical Laboratories is greatly strengthened through these contracts; they bring us many new ideas and speed up the attainment of our goals. Each principal investigator under these contracts becomes in effect a special consultant to the Chemical Corps. At the same time the member of our staff who is assigned the administrative responsibility for the contract gains much from his visits to the principal investigator. It is not his function to tell the principal investigator what he shall do or how he shall conduct the study. The scope is agreed on in advance; how the scientist attacks the problem is his own business.

Figure 12
Staff of the Clinical Investigation Branch, Clinical Research Division

Achievements of Chemical Corps Medical Laboratories: Research Project in the Toxicology Division

In presenting some of the achievements of Chemical Corps Medical Laboratories an arbitrary selection will have to be made. Four topics have been selected, one for each of the four research divisions. The first of these, Toxicology Division, besides its work on chemical warfare agents, is engaged in the study of "Military Chemicals." This project is jointly supported by the Army, the Navy and the Air Force. It is concerned with the hazards involved in the handling of chemicals that modern warfare has introduced. The several cate-

Figure 11
Personnel of the Pathology and Clinical Investigation Branches, Clinical Research Division

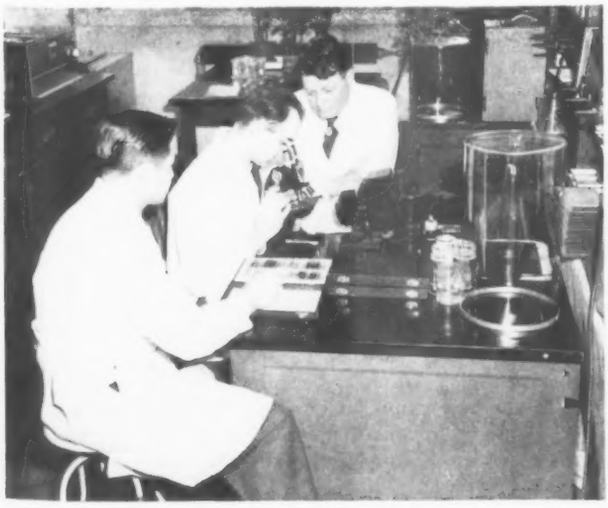


Figure 13
Rabbit Colony, Veterinary Branch, Technical Services Division

gories include fuels used for jet propulsion (such as red fuming nitric acid), fire extinguishing agents and hydraulic fluids. The concentration of research on such compounds in one service laboratory is convincing evidence that the unification policy works. Assignment of this responsibility to the Chemical Corps Medical Laboratories was agreed to because of our unique facilities and versatile and competent staff. Coordination is effected through various panels and committees of the Research and Development Board, Department of Defense. Under this project we have evaluated the acute, subacute and the chronic toxicities of twenty or more compounds. The nature of the injuries produced is being studied and precautionary and treatment measures are being developed. While the major investigations to date have been in the Toxicology Division the other divisions have had important roles. During the next year increased emphasis will be placed on clinical aspects and on synthesis of the findings in terms that can be understood and applied by those who are developing and using these categories of compounds. The reports on this work will be available to the public in most instances. The primary purpose of these studies is to protect the health of those in the military service who are liable to be exposed to these chemicals. It is certain, however, that application of the findings will be much broader than this; the number of people concerned with jet propulsion is increasing and the choice of fire extinguishing agents is a matter that affects every household.

Research Project in the Physiology Division

The project in the Physiology Division selected for presentation is entitled "Mechanism of Action of Insecticidal Compounds." This project of the Entomology Branch, is of interest both to the Chemical Corps and to the Medical Services. The Chemical Corps is interested because of the relations between some insecticides and chemical warfare agents. For example the nerve gases, discovered and developed in Germany during World War II, resemble in their physiological action two commercial insecticides, parathion and tetraethyl pyrophosphate, TEPP. Much as insects differ from mammals, the two classes possess in common an enzyme, cholinesterase, which is involved in nerve activity. Much has been learned about the mechanism of action of this group of poisons by the insect physiologist.

It is my good fortune to be able to quote from a recent issue of *Science* (14 March 1952) an authoritative statement about this project and about our Entomology Branch. The author, Dr. Kenneth P. Roeder, is professor of physiology at Tufts College. He and Dr. Chadwick have been closely associated professionally for many years and have written several papers jointly. The contractual relation between the Chemical Corps and Tufts under which Dr. Roeder is principal investigator, has been a highly fruitful one.

". . . during the closing year of the war . . . several other agencies, notably the Army Chemical Corps, Quartermaster Corps, and the Public Health Service, farsightedly realized that, although their interests in insects and chemical action were of a purely practical nature, the surest way to achieve their objectives was to support studies of insect function in which the development of new insecticides was incidental. This support has continued, and at the present time the Army Chemical Corps has one of the finest laboratories in insect physiology in the United States in its Entomology Branch at Edgewood, Maryland. In addition, this and other agencies support university research in insect physiology by means of contracts. . . .

"The intelligent attitude of these supporting agencies has eliminated much of the proverbial distrust of university workers for sponsored research, and has brought about a natural fusion of the objectives of the two groups. For instance, determination of the gustatory and olfactory thresholds of flies in relation to the structure and properties of the stimulating compounds has certainly enlarged our knowledge of this branch of sensory physiology, and at the same time suggests a rational basis for the synthesis of specific insect attractants and repellents. Work begun with the practical object of determining the site and mode of action of agents such as DDT, diisopropyl fluorophosphate, and hexaethyl tetraphosphate, has also supplied information on sensory function, ganglionic activity, and the chemical factors in synaptic conduction in insects. Similarly, a knowledge of the energetics of flight and of the behavioral mechanisms of insects is clearly prerequisite to a rational understanding of insect migration and distribution, although these topics have an obvious intrinsic importance. Similar examples are to be found in work on the cuticle, metabolism, biochemistry, and developmental physiology of insects.

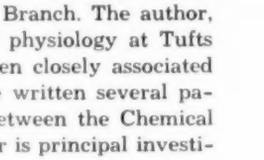
"At the present time great interest centers around the appearance in the field of strains of houseflies and mosquitoes highly resistant to DDT. This situation can be duplicated in the laboratory when flies are subjected to the selective action of DDT for five to eight generations. The structural and functional modification conferring resistance to DDT has not yet been detected, but this practical problem offers ideal experimental material for a study of the changes that form the basis of natural selection. From the physiological viewpoint alone, the problem stretches all the way from the ultra-structure, chemistry, and physical properties of the cuticle as the point of entry of DDT, to the properties of the excitable tissue affected and the nature of the enzyme systems basic to metabolism and excitability. Solution of this problem will fill many gaps in our knowledge of the physiology of insects, as well as provide a highly significant contribution to human health and welfare."

Research Project in the Biochemistry Division

The research project in the Biochemistry Division chosen for the purposes of this paper is in the area of basic research. There are practical goals in view but they probably are not close at hand. Nevertheless the promise of an eventual solution of a critical problem is favorable enough to win strong support for this project: the biochemical action of the nerve gases.

One of the best known members of the nerve gas family is DFP, diisopropyl-fluorophosphate (Figure 14).

FIGURE 14



di-isopropyl ester of
fluophosphoric acid
(DFP)

The drug has been used commonly because of its availability, its relative potency and its relative resistance to hydrolytic decomposition. It has long been known that it inactivates cholinesterase irreversibly. Two investigators in Chemical Corps Medical Laboratories, Drs. Michel and Stephen Krop (formerly chief of Pharmacology Branch) were the first to show conclusively that this irreversible inactivation is due to a direct stoichiometric combination between the enzyme and DFP. Using DFP labeled with radioactive phosphorus, they proved that at least the P of DFP becomes firmly attached to the enzyme. Since then great progress has been made by Dr. Summerson and his staff, especially Drs. Bernard Jandorf and Norwood K. Schaffer. Since cholinesterase is available only in small quantities, they turned their attention to chymotrypsin. This is also inactivated by DFP and it is available in sufficient amounts and purity for biochemical studies. Jensen, Balls et al had already shown it reacts quantitatively with DFP, molecule for molecule. In the process

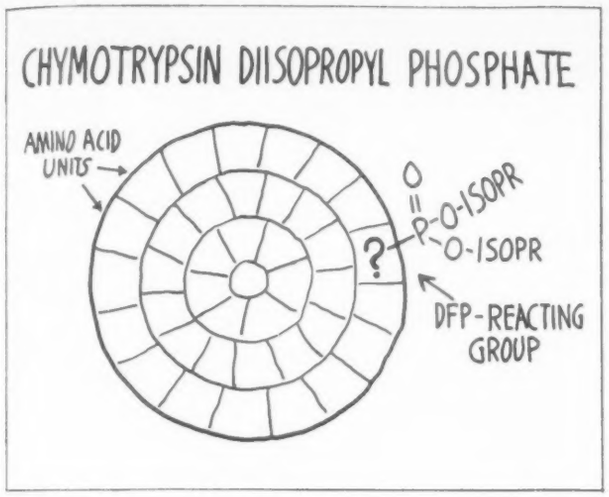


Figure 15

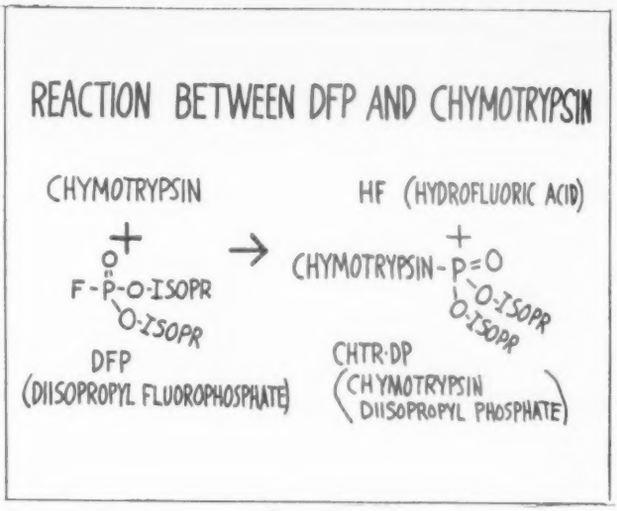


Figure 16

the F of DFP was liberated and a diisopropylphosphoryl radical became bound to the enzyme molecule (Figure 15).

The DFP-inactivated enzyme could be isolated and crystallized in any desired amount. The availability of this material appeared to offer a practical basis for establishing the chemical nature of the combination between enzyme and DFP.

The nature of the problem at this point is illustrated schematically in Figure 16. Chymotrypsin (mol. wt. about 25,000) contains between 200 and 250 amino acid residues, of which *only one* has reacted with the DFP; the possibility that an as yet unknown amino acid or non-amino acid moiety might be concerned is also present. Careful fractional degradation of the molecule, and isolation and characterization of the DFP-bound moiety appeared to be the most logical method of approach. This procedure has been followed, using radiophosphorus-labeled DFP to mark the desired fractions.

The degradation procedure which has worked successfully is outlined in Figure 17.

FIGURE 17
ISOLATION OF DFP-REACTING GROUP OF CHYMOTRYPSIN

CHTR-DP

PEPSIN

PEPTIC PEPTIDES

TRYPSIN

TRYPTIC-PEPTIC PEPTIDES

PARTIAL HC HYDROLYSIS

PARTIAL HC HYDROLYSATE (MOSTLY AMINO ACIDS)

DOWEX-50 (OR STARCH) CHROMATOGRAPHY

UNBOUND PHOSPHORUS FRACTIONS

BOUND PHOSPHORUS FRACTIONS CONTAINING DFP-REACTING GROUP

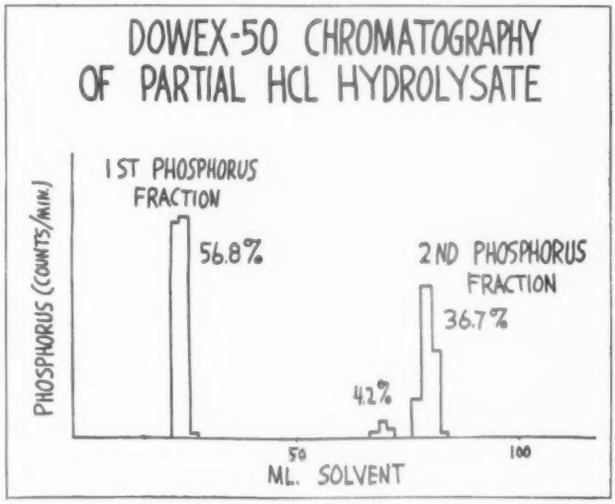
This involves successive treatment of the labeled recrystallized chymotrypsin-DFP reaction product with pepsin and trypsin, followed by controlled acid hydrolysis. Acid hydrolysis alone, without enzymatic pre-treatment, gives essentially the same results. The hydrolysate can then be fractionated on either starch or Dowex-50 columns, to yield several phosphorus-containing fractions (Figure 18). The first fraction contains inorganic phosphorus, presumably produced by acid hydrolysis of all organic groups bound to phosphorus. The remaining fractions contain phosphorus bound to organic material.

Paper chromatography of various cuts in the second major phosphorus-containing fraction revealed that the radioactivity was closely associated with a single ninhydrin-reacting component, and that after drastic acid hydrolysis of this material the phosphorus was split off and a new faster-moving ninhydrin-reacting compound resulted (Figure 19).

It was easily possible to identify the material as serine by paper chromatography. Microbiological assay for serine gave independent confirmation of this.

It is to be concluded therefore that, when DFP reacts with chymotrypsin, the ultimate (but not necessarily the immediate) site of binding is through the hydroxyl group of one of the serine moieties in the enzyme. The acid lability of isopropyl groups attached to phosphorus has thus far prevented the isolation of diisopropylphosphoryl serine. Of interest is the fact that serine itself does not react with DFP under conditions where the enzyme reacts rapidly and completely. Furthermore, there are some 20 or more serine residues in chymotrypsin; only one of them appears to be concerned in the DFP reaction. It appears likely that a particular spatial configuration at or near one of the serine residues is an important part of the picture, and that a final explanation for the reaction between the enzyme and DFP must await characterization of the polypeptide chain in the neighborhood of the bound serine. Such studies are in progress.

Figure 18



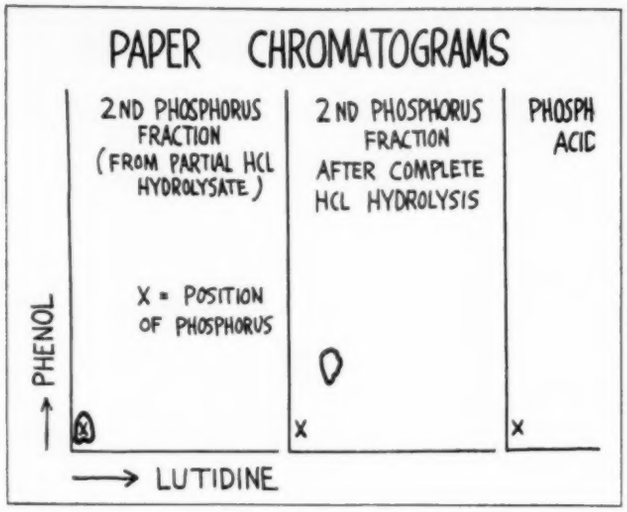


Figure 19

Research Project in the Clinical Research Division

The Clinical Research Division, as already pointed out, is concerned with the treatment of casualties from chemical warfare. Since the development of nerve gases in Germany early in the past war, attention has been given to the mechanism of action of these substances and to the means for treatment. The usefulness of atropine was discovered in Germany; this drug was incorporated in their treatment kits. Research in Chemical Corps Medical Laboratories indicated that artificial respiration will be necessary also. The project of Clinical Research Division which I wish to describe has to do with the latter problem.

In January, 1950, the Secretary of Defense requested the Medical Services to revise the Training Manual, "Treatment of Casualties from Chemical Warfare Agents." A committee of three officers was assigned the responsibility, Colonel John R. Wood, MC, by the Army; Commander Paul F. Dickens, MC, by the Navy; and Major John Rizzolo, MC, by the Air Force. Colonel Wood was then Chief of the Medical Division (later designated Medical Laboratories) of the Army Chemical Corps. The committee decided that methods for manual artificial respiration should be included in the manual.

There was evidence that the Schafer manual method commonly in use in this country was inadequate. It also was clear that there were sharp differences in opinion regarding the efficacy of mechanical devices and their applicability to military situations. Hence it was decided to bring together at Medical Laboratories several groups concerned with artificial respiration, both manual and mechanical. The Chemical Corps underwrote the meeting and arranged to hold it at Army Chemical Center, 29-30 September, 1950. The Medical Services were represented by officers familiar with design and procurement of equipment and by the officers responsible for research and development, both as related to equipment and also to methods of treatment. The physiologists who participated included outstanding experts in the field of respiration, led by Wallace O. Fenn, Professor of Physiology, University of Rochester.

The committee was about to edit the final draft of the training manual at the time this conference was held. On the basis of the evidence presented at the conference, they decided to include two push-pull methods. The first of these had been proposed in 1932 by Colonel Holger Nielsen, of the Danish Army. The second, devised in Ivy's laboratory, was designated the hip-roll prone-pressure method. The committee and physiologists participating in the conference agreed that the evidence available was insufficient for choosing the best method and that further research should be carried out.

At the conclusion of the conference Colonel Wood decided to seek the joint support of the Navy and Air Force in an attack on the problem of manual artificial respiration. By 11 October he had obtained the promise of joint support from the Navy and Air Force, with the Office of Naval Research writing the necessary contracts. Invitational orders were written inviting several potential investigators to a planning meeting in Washington on 8 November. He and his counterparts in the Navy and Air Force asked the author to preside at this meeting and to act as coordinator of the research program to be initiated. Developments during the next year illustrate the potentialities of close collaboration between military research agencies and non-military laboratories.

Growing out of this meeting four groups of investigators agreed to evaluate methods of manual artificial respiration, Schafer, Silvester, Holger-Neilsen, back-pressure, hip-lift and back-pressure, hip-roll.

Two of the investigators proposed comparing the above five methods on apneic hospital patients. Dr. Julius H. Comroe, Jr., was to accomplish this in the University of Pennsylvania Hospital. Dr. James L. Whittenberger proposed doing so in the hospitals affiliated with Harvard Medical School.

Dr. Peter V. Karpovich planned to use student volunteers at Springfield College. Selection of "victims" and operators would insure a wide range of body weight and body build. His studies would include pulmonary ventilation, energy cost, fatigue, and pedagogical factors.

Dr. Archer S. Gordon with the advice of Dr. A. C. Ivy, University of Illinois, proposed applying the five methods to anesthetized and curarized volunteer subjects. He reported a preliminary study just completed on ten such subjects which was published shortly thereafter. This work needed to be extended, using enough subjects to provide a valid statistical basis for choosing method or methods to be incorporated in manuals.

There was unanimous indorsement of these proposals by those attending the conference including representatives of the three Medical Services and of the following agencies:

American Red Cross, Dr. Carl J. Potthoff.

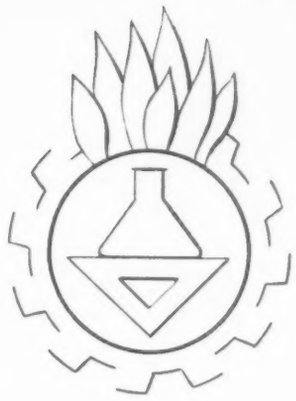
National Security Resources Board, Dr. Thomas C. Anderson.

Office of the Secretary of Defense, Office of Medical Services, Colonel George E. Green, MC, USAF.

The four investigators submitted formal proposals within a few weeks and soon received assurance that they would be approved. Their studies began at once. These were well advanced when we met again in April. At that time it was proposed that a pedagogical study be carried out on a large number of enlisted personnel, using the two methods considered best. This proposal was approved within a few days and the work was undertaken by Dr. Gordon and Mr. Creighton Hale of Dr. Karpovich's staff. With the help of the Great Lakes Naval Training Center, the two methods of choice were tried out on a large number of naval personnel. All observations were completed within a month of the time the proposal was made—a remarkable record of efficient administration on the part of the Office of Naval Research and of effective collaboration between a group of university scientists and a military training center.

The investigators met next in Philadelphia on 9 June to review their latest observations. These included Gordon's highly important blood gas studies on apneic volunteers while manual artificial respiration was being applied. The joint studies on Naval personnel also had been completed. On the strength of all the evidence presented, it was unanimously agreed that the back-pressure, arm-lift method, essentially as devised by Holger Nielsen, should be given first preference and the back-pressure, hip-lift method, second. This conclusion was communicated to the chiefs of medical research and development of the Army, the Navy, and the Air Force on 12 June. Papers were then prepared for publication. These were published together in the *Journal*

(Continued on page 51)



For over a decade
our entire organization and facilities
have been devoted exclusively to
the design and production of

FLARE AND SIGNAL MUNITIONS

PHOTOFLASH MUNITIONS

DETONATOR AND BURSTER COMPONENTS FOR AMMUNITION

★ ★ ★

SHELL AND FUZE LOADING

AERIAL PRODUCTS, Inc.

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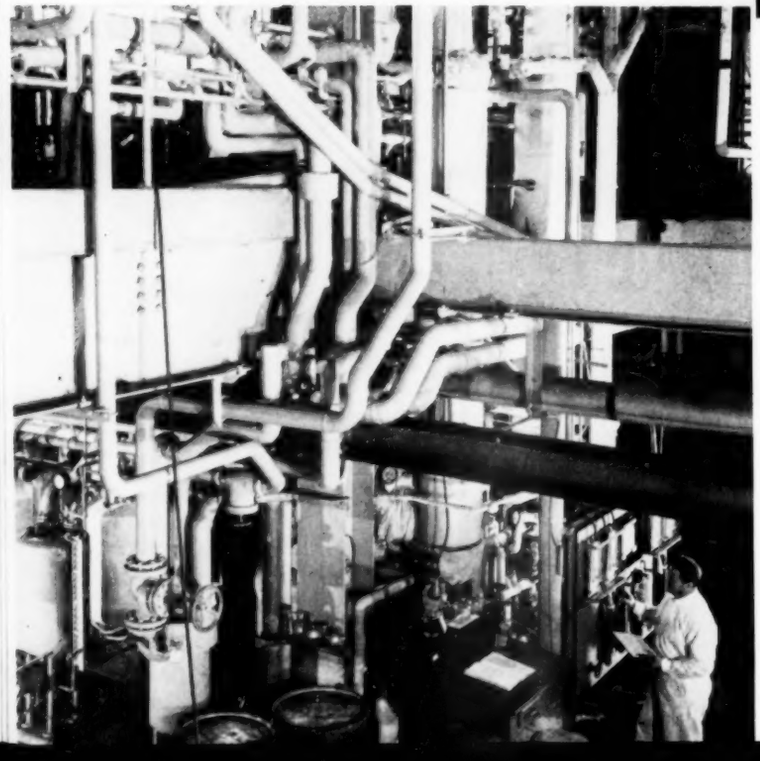
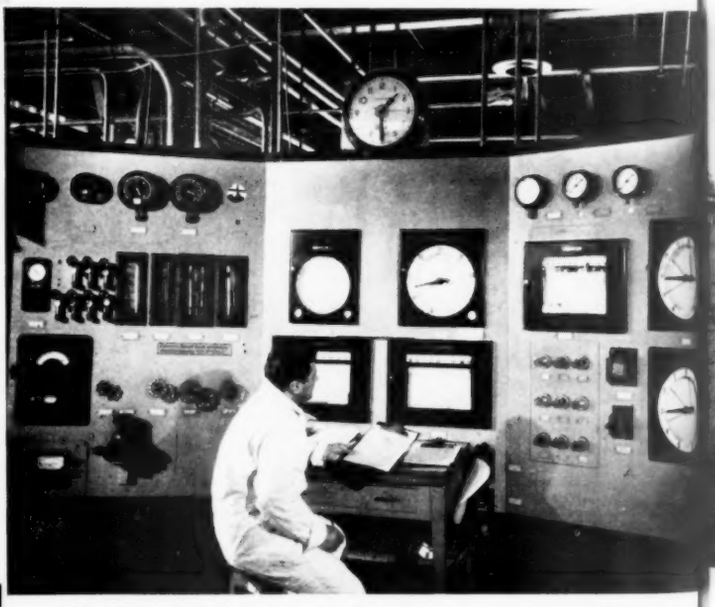
In the event of a future "total War," blood plasma expanders such as PVP (polyvinylpyrrolidone) would play a major role in the treatment of civilian casualties that would result from the mass-bombing of crowded cities.

PVP

A CHEMICAL CONTRIBUTES TO DEFENSE





GAF's "New Fields" pilot-plant at Grasselli, N. J., has been hailed as one of the most significant achievements in American chemical engineering within recent years. The plant has a present capacity equivalent to 5,000,000 units (pints) of PVP plasma expander a year. Installation of standby equipment could, within a short time, increase the capacity more than threefold. The big thoroughly instrumented plant contains more than $1,000,000 of specially-designed equipment for the manufacture of PVP alone, and constitutes the only PVP production facilities in the Western hemisphere.

One of the most staggering materiel problems that would arise if the nation became involved in another major global conflict would be that of achieving and maintaining an adequate supply of blood plasma and whole blood to treat military and civilian casualties. Particularly arduous would be the task of securing quickly the large amounts of these life-saving fluids that would be needed to give prompt medical care to the thousands of casualties that would result from the massbombing of crowded industrial centers.

An admittedly conservative estimate of 3,000,000 units (pints) of blood plasma would be required to meet such an emergency, according to a recent publication of the Federal Civilian Defense Administration. This estimate is conditioned upon the existence of equipment for the rapid collection and administration of an additional 3,000,000 units of whole blood and it does not include any provision for replacement supplies or the setting up of local reserves in critical target areas.

It is a reasonable assumption that no program for the collection of whole blood or the preparation of natural plasma could by itself meet the requirements for the care of the civilian casualties, let alone the military casualties, of any future "total war."

For this reason considerable attention has been given by government authorities to the role that man-made plasma substitutes, known as blood plasma expanders, must play in the defense plans of this country and its allies. Prominent among these materials is PVP (polyvinylpyrrolidone), made from easily available acetylene gas by a carefully controlled synthesis process, and approved by the National Research Council in December 1951 for emergency stockpiling.

Originally produced in Germany, PVP was successfully used in the treatment of hundreds of thousands of German civilian and combat casualties during World War II. It was employed by German army physicians and surgeons in the form of a water solution containing in addition to 3.5 per cent PVP, small quantities of physiological inorganic salts to render it compatible with human blood. German medical records of the time report that this PVP solution, called by them Periston, was utilized as an emergency blood substitute on

the battlefield, for treatment of burn shock, in post-operative therapy and in many circulatory disturbances resulting from infectious diseases and other causes.

With the advent of the Korean conflict, the Department of Defense requested the National Research Council to make a detailed evaluation of plasma expanders. PVP, because of its successful history of use in Germany, was logically included in the project.

The NRC was assisted in its study of PVP by the technical staff of General Aniline & Film Corporation, the only manufacturer of the material in the Western Hemisphere. GAF turned over to the NRC results of its own extensive research and development program on PVP which had begun in 1946, and made available about 13,000 units (pints) of PVP solution to the NRC and leading clinics and laboratories for testing.

The Company also made available to the government group on a cost-free basis the chemical, physical and analytical services of its own large research staff, who actively worked with the NRC in developing the critical product specifications for the material. Acting on the findings of this exhaustive study, the NRC in December of 1951 approved the stockpiling of PVP for emergency use.

selli, New Jersey, is represented by the complicated processing equipment needed to manufacture PVP.

The only other facilities for the production of this life-saving material lie in Europe, in an area most sensitive to political upheaval and vulnerable to the ravages of any future war. For this reason GAF, since the outbreak of the conflict in Korea, has revised its long-range plans regarding PVP to include the possibility of expanding its already sizeable production capacity to a point that could serve America's allies too.

PVP—A Product of Long Research

GAF's commanding position in the manufacture of PVP and other unusual acetylene derivatives, is best understood in the light of the Company's well-earned reputation as a pioneer in high-pressure acetylene technology. Its initial interest in this field stemmed directly from GAF's connection with the I. G. Farben chemical interests of Germany prior to 1942. As a consequence of the seizure of GAF by the Federal Government, following America's entry into World War II, the new American management's attention was drawn to some patents which the Company had purchased from the I. G. two years earlier. These patents covered some of the basic work of Dr. J. Walter Reppe, a chemist in I. G. Farben's lab-

A whole new realm of commercial chemistry was opened in the 1930's when the German chemist, J. Walter Reppe, mastered the difficulties of handling acetylene gas under high pressures to synthesize many valuable products. GAF quickly realized the significance of Reppe's work and as early as 1942 launched its famous "New Fields" program in high pressure acetylene chemistry which culminated in the development of the remarkable blood plasma expander, PVP. Figuring importantly in this accomplishment were the High Pressure Laboratory (above) at GAF's Central Research Laboratory at Easton, Pa., and the Company's multi-million dollar pilot-plant at Graselli, N. J.

PVP's physical and chemical properties are admirably suited to such stockpiling. As the fundamental dry white powder ready for make-up into clinical solutions, it may be stored indefinitely. And in the form of a heat-sterilized solution, packaged in plasma bottles ready for use, it may also be stored for long periods of time under reasonable conditions. The stability of aqueous solutions of PVP even at boiling temperatures is an important factor in the sterilization of the product for medicinal use.

GAF's wealth of "know-how" in the manufacture, formulation and clinical use of PVP is the result of a methodical and costly program to extend the original German research in the field. This effort has constituted a major portion of the Company's overall research on the Chemistry of acetylene, basic raw material for PVP. Nearly $500,000 has been spent by GAF on investigatory and development work involving this versatile plasma expander alone, and over $1,000,000 of the Company's investment in its large modern pilot plant at Grasoratories at Ludwigshafen, Germany, and related to the use of acetylene gas under conditions of high pressure to synthesize many important chemical products.

Prior to this work by Reppe, chemists in this country and elsewhere had confined their interests in acetylene-based syntheses to those using acetylene under moderate pressures. This was due primarily to the difficulty and danger of handling this highly explosive material under high pressure. In addition, there was not the compulsion, as there was in Germany, to base so much of the chemical industry on the use of coal and coke-derived raw materials such as acetylene.

The American management of GAF, however, quickly realized that Reppe's mastery of the difficulties of handling acetylene under high pressures opened up an entirely new realm of commercial organic chemistry. Almost immediately, GAF launched its "New Fields" program to extend its know-how in the manufacture of acetylene chemicals. Within a very

short time the American war effort was supplied with two very vital acetylene-based products: Polectron, a dielectric material for use in proximity fuses; and Koresin, a tackifier for synthetic rubber.

The end of the war brought an easing of equipment and material shortages and made it possible for GAF to design and procure the highly specialized pressure-proof equipment needed to pursue further research and development work on PVP and other acetylene chemicals. The staff at the Company's Central Research Laboratory at Easton, Pennsylvania, was increased to handle the intensified assignment and high-pressure laboratory facilities were established to study acetylene-based syntheses.

Government-Industry Teamwork

The first quantities of GAF's PVP, the most important product to emerge from the "New Fields" program, were made in the Company's laboratories in 1946. A short time later, the Company initiated a program to investigate all possible physiological properties of PVP. The study included a large amount of investigatory work on PVP as a blood plasma expander at the Philadelphia General Hospital and a report submitted in late 1948 concluded that PVP showed excellent properties as a blood plasma substitute. To corroborate these findings, samples of PVP were then supplied by GAF to the Mayo Clinic. During the summer of 1949, a Mayo report cited the value of the material as a blood plasma substitute in combatting shock.

By September, 1949, demand for PVP for investigatory work had reached a point where it became necessary to transfer its manufacture to GAF's new Grasselli pilot plant. This was not fully accomplished until September, 1950, since much of the elaborate and costly equipment needed to manufacture the material on a production scale had to be specially designed and fabricated.

In the meantime, starting in 1948, GAF scientists established contact with the Armed Forces to advise them of the progress the Company was making in its PVP program and supply them with up-to-the-minute results of the extensive clinical tests the Company and various cooperating groups were running on PVP.

By late 1950, the Armed Forces Medical Policy Council of the Defense Department and the NRC were informed that GAF was in successful pilot plant production of PVP and was ready to cooperate with any defense agency in the development of suitable plasma expanders for use by the Armed Forces and for stockpiling for civilian defense purposes. This situation also made it possible for GAF to supply the National Research Council with the large quantities of PVP it needed for its clinical testing. At the same time the GAF scientific staff performed considerable cost-free laboratory work for the NRC requiring at times the assignment of as many as 70 laboratory personnel to the single project of PVP. One indication of the size of work required some 20,000 difficult time-consuming analytical tests to be run. Another is found in the size of the large clinical testing program that was carried out on human volunteers.

Still another contribution to research on plasma expanders, was the publication by GAF in 1951 of the most complete medical bibliography on the clinical use of PVP to date. Currently, this work is being revised for even more extensive use by research people in the plasma expander field.

Throughout the entire American development of PVP, GAF scientists, impressed by the urgency of the program, repeatedly undertook the quick solution of difficult problems that threatened to delay the whole NRC program. An example of this was the manner in which the Company was able to supply the NRC in January, 1951, with samples of the first radioactive PVP ever made only a few weeks after NRC officials mentioned their need of this material for a particular clinical test.

Even after the NRC granted its approval in late 1951 for the emergency stockpiling of PVP, GAF research on it continued. Currently, members of the Company's technical staff are actively engaged in cooperative work with the NRC toward the development of a further improved product suitable for wider employment.

Production—A Careful Job

As might be assumed from the length of its full name, PVP is a highly complicated chemical compound. GAF manufactures it by the only commercially feasible process known to date, one requiring 13 successive processing steps, each of which must be executed with precise control. Six of these steps are chemical in nature, growing progressively more complex as the chemically simple starting molecules of acetylene are converted into bigger and more intricate molecular configurations culminating in the fifth chemical step with the formation of vinylpyrrolidone.

This material is the basic "building-block" or monomer of PVP, which in turn is formed in the sixth step by chemically hooking hundreds of these monomers to one another in an elongated chain-like manner to form the polymer, PVP. This sixth step, known as polymerization, requires extremely critical control to obtain a polymer of the correct chain length for use as a plasma expander. The predictability with which this control is effected is a tribute to the long years of work by GAF scientists.

Each of the above chemical steps is followed by a purification step to remove unwanted side-products of the reactions that might contaminate the intermediate materials and cause subsequent chemical steps to go awry. The final operation in the whole process is that of spray-drying, which yields the pure white PVP in a physical form easy to formulate for clinical use as a solution.

GAF's PVP plant is supplied by an adjoining acetylene generating plant which manufactures the gas by the reaction of water with calcium carbide, a chemical produced directly from coke. This places GAF in the unique integrated position of being able to produce pharmaceutical grade PVP, ready for use in clinical solutions, from basic raw materials only a step or two removed from nature. Operating on this basis the plant is capable of producing sufficient PVP for 1,000,000 units (pints) of plasma expander annually.

In accord, however, with the Company's policy to keep its plant in readiness for the tremendous PVP demand that might be occasioned by a major war, GAF has stockpiled by purchase of sizeable quantities of butanediol, the material that is formed in the second step of the PVP synthesis. The use of this compound as the starting material enables the plant to swing over its unique facilities to carrying out the third to sixth steps in the PVP process, the critical operations which no other chemical plant in this part of the world is able to perform. Operation on this basis increases the rated capacity of the plant about five-fold.

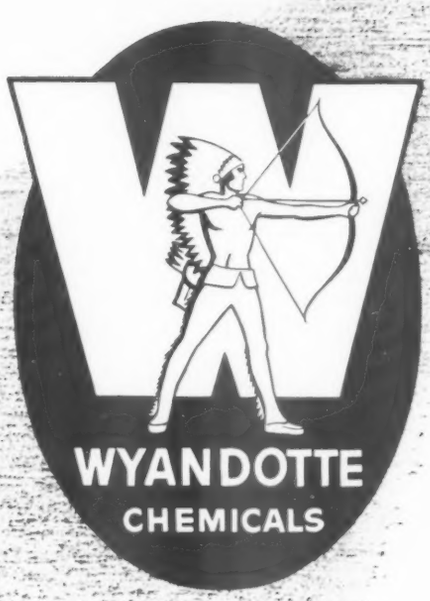
Provision for still greater expansion has also been made by the acquisition of additional new production equipment. These units, already on the plant site, could be installed when needed to raise the capacity to an equivalent of well over 16,000,000 units annually.

PVP in Medicine

PVP has many promising applications in medicine other than as a blood plasma expander. This use, however, is the one of greatest immediate significance because the restoration of blood volume is a principal element in the modern treatment of impending or existent shock resulting either from loss of blood or other causes. In conditions involving the loss of plasma rather than whole blood, a substance which is capable of increasing the blood pressure and circulating blood volume, and maintaining these levels until the body recovers from the effect of shock, is an invaluable substitute for natural plasma for these purposes.

Although a blood transfusion is the ideal therapy in the case of a severe hemorrhage, a satisfactory substitute such as PVP may save lives in an emergency by supporting the cir-

(Continued on page 50)



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ARMED FORCES RESERVE ACT OF 1952

Limitation of space prohibits this publication from devoting more than a fraction of its contents to the recently enacted Armed Forces Reserve Act of 1952, called the biggest single piece of legislation in history devoted to the Reserve Components of the Armed Forces.

Complete copies of the act are available to interested parties in two ways: Bulletin No. 7, published by the Department of the Army 16 July, contains the act in its entirety. It is being distributed down to company unit levels, but is not available to individuals for their personal files. A copy of the act, called PL 476-82nd Congress, may be obtained by writing the Supt. of Documents, GPO, Washington 25, D. C., and enclosing 10c.

Here, in extremely abbreviated form, are some of the provisions of major interest:

UNIFORM ALLOWANCE: Hereafter non-regular officers will be entitled to an initial uniform allowance of $200, a maintenance allowance of $50 for every four years satisfactory inactive duty, and an active duty allowance of $100 when ordered to active duty or active duty for training for a period of more than 90 days. This latter allowance of $100 is retroactive for officers entering on active duty after June 25, 1950 but may not be paid unless two years elapse following a previous active duty tour, for which a previous payment of this type was made.

ACTIVE DUTY ORDERS: 30 days minimum notice, subject to military conditions, will be given those recalled to active duty. The Ready Reserve, units and individuals, may be ordered to active duty under Presidential emergency, but Congress must determine the actual number to get orders, except in case of war or Congressional emergency, when all may be called. The Standby Reserve, either units or individuals, cannot be called except in war or Congressional emergency or where specifically authorized by Congress and then only after Ready Reserve units or individuals in the required categories are not readily available. When possible, reservists will be called as units, but reassignment after recall is permitted. Qualified Retired Reserves may be called in time of war, Congressional emergencies, or when authorized by Congress. After any combination of Ready Reserve and active duty service which the Secretary may prescribe up to a total of five years, reservists can on their request move into the Standby Reserve.

OFFICER COMMISSIONS: Commissions hereafter will be for an indefinite period. Those now having term appointments may accept the indefinite appointment, or let their current appointment as extended, expire, April 1st, 1953 will probably mark the expiration of all appointments which are five or more years old on that date.

TERM OF ACTIVE DUTY TOURS: The act gives authority to the services to offer contracts to non-regulars for active duty tours, except in time of war, running up to five years and will provide severance pay of one month's pay and allowances for each year of the contract term not served through no fault of the individual. Contracts may be renewed. Details are to be worked out by the services. The services are permitted to effect this portion of the act prior to 1 January.

DISCRIMINATION: The act prohibits discrimination between non-regulars and regulars in laws that apply to both.

NATIONAL GUARD: The dual status (State-Federal) of the National Guard is continued under this law. Dual oaths to the State and Federal Governments are continued in effect. Common Federal appointments and enlistments, however, are provided for members of the National Guard of the United States and the Army Reserve. This means that transfers may be effected between the National Guard of the United States and the Army Reserve and vice versa without the necessity of new appointments when there is no change in grade. All units and members of the National Guard of the United States are assigned to the Ready Reserve.

RECORDS: "Adequate and current" personnel records must be maintained, showing family status, physical condition and occupational specialty, etc.

PHYSICALS: Physical examinations must be given at least every four years and a personal certificate of physical condition must be submitted annually.

It should be re-emphasized that this is a very brief statement of a few of the high points of the act, which fills 28 printed pages in Bulletin No. 7. Except for a few provisions, the act does not go into effect until 1 January 1953 and probably will not be felt for months even beyond that date. The act limits the "Ready" Reserve to an aggregate of 1,500,000 for all services. This includes the National Guard and all Reservists in active services. It also provides that complete and up-to-date information must be supplied to all members of reserve components and to the general public.

(Note: This abstract of the Reserve Act is reprinted from the September issue of "REPORT TO THE ARMY.")

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Napalm

The deadly effectiveness of Napalm as an all-purpose weapon is seen in the fact that the Armed Forces fighting in Korea have already used more than four times as much of the gasoline thickener as was used in all of World War II. The Army Chemical Corps, which produces the Napalm for all of the services, says that the bulk of the thickener supplied has gone to the Air Force, which uses it against enemy troops in close ground support and in burning out enemy troop and supply concentrations. At last reports, the Air Force was dropping an average of 70,000 gallons of napalm a flying day. This is in addition to the amounts used by the Navy airmen and by the ground forces themselves.

It has been a long-standing maxim in the Army that "the best defense against a tank is another tank," but the Korean war has proved that one of the best anti-tank defense is an airplane belly-tank full of napalm dropped from a plane. The Operations Research Office recently reported that the napalm bomb, an Army Chemical Corps World War II development, had accounted for nearly as many enemy tanks in Korea as all other weapons combined.

———o———

The Army Chemical Corps has developed a new assault weapon—a giant flame thrower used as the main offensive armament when mounted on the newest type medium tank. Previously, tanks used flame as an auxiliary weapon.

WITCO *steps up production*

to meet vital defense needs

with new manufacturing facilities . . .

In Chicago, Ill., Witco's expanded facilities have more than doubled production of Napalm and other vital chemicals.

In Lake Charles, La., Witco-Continental's new plant, capacity 25 million lbs. a year, is in full-scale production of High Abrasion Furnace black.

In Sunray, Texas, Witco-Continental has substantially increased its facilities for production of Semi-Reinforcing Furnace black.

with new research laboratories . . .

In Chicago, Witco has added a two-story wing to its research and technical service laboratory. Work will be carried out on a variety of important organic chemicals.

In Amarillo, Texas, Witco has opened a new laboratory devoted to research and technical service on carbon blacks.

All Witco facilities stand ready to serve the vital needs of defense, in production or in research. Inquiries will receive prompt attention.

A few of Witco's products meeting government specifications . . .

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Barium Stearate (JAN-B-366)
Calcium Stearate (JAN-C-263)
Magnesium Stearate (JAN-M-542-Ammunition) (JAN-M-560-Ointment)
Lead Stearate (for ammunition) (JAN-L-758)
Copper Naphthenate (for many mildewproofing specifications)
Drier, Paint, Liquid (TT-D-651a) Type I and Type II
Drier, Naphthenate, Concentrated, Liquid (Navy 52-D-7) (AN-TT-D-643) Type I, Lead 24%; Type II Cobalt 6%; Type III Manganese 6%; Type IV Zinc 8%
Linoleate, Manganese (MIL-L-15188-Ships)
Resinate, Calcium, Type I (USA-50-11-896)
Resinate, Manganese (Navy 52-R-8a)
Resinate, Sodium (MIL-S-6138-Aer.)
Zinc Naphthenate (for use in Army Spec. AXS-1296) (52-D-7 Navy) (AN-TT-D-643)
Wood Preservative, Copper Naphthenate (52 W 5 Type A)
Carbon Black, Dry (for explosives) (JAN-C-306)
Case Liner Adhesive (JAN-P-140, Type II, Grade A)
Paint, Acid Proof, Black (for ammunition) (JAN-P-450)
Composition, Top Coating Material Bituminous (JAN-P-102)
Compound, Chassis Coating (Army AXS-1827)
Compound, Protective Strippable (Army AXS-1756)
Compound, Rust Preventive Thin Film (Army AXS-673)
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History of the
NEW YORK CPD

By MAJOR JOHN F. CARROLL, Cml.C. Res.

Photo—Sgt. Campos, 1st Army

New York Chemical Procurement District, 180 Varick Street. Scene in the new temperature controlled gauge laboratory. Left to right: Mr. William Kracov, Capt. Arthur R. Rauch, Organization Control Officer; Mr. Jerome H. N. Selman, Asst Chief Inspection Division, and Capt. Abe L. Selman, Chief Inspection Control Branch, checking ignition cylinder components for the portable flamethrower.

The present New York Chemical Corps Procurement District came into being when War Department Special Order No. 278, 1 December 1923, appointed 1st Lt. Joseph F. Battley as "Executive Officer" of an non-existent facility. However, to understand the functions and growth of this operation, it is necessary to review some Chemical Warfare History.

When the Germans started modern gas warfare by first using chlorine against the French and Canadian troops at Ypres on the afternoon of 22 April 1915, they not only caught the Allies flatfooted, but shocked the rest of the world by this unorthodox application of an industrial, commercial item to war use. In December of the same year the Germans, in an effort to maintain their chemical warfare supremacy, introduced with marked success phosgene. Yet, for the ensuing two years until 6 April 1917, when the United States declared war on Germany, there was no appreciation of this new weapon or even actual effort by the War Department to inaugurate research into the offensive or defensive uses of chemical munitions, much less the more important aspect of how they were made or purchased, where and from whom.

Not only is this conclusion borne out by the records, but even by Major General William L. Sibert, first Director of the Chemical Warfare Service (after whom the great C.W.S. World War II training camp was named), who, when writing in August 1921, stated: "I say that there is no field in which the future possibilities are greater than in Chemical Warfare and no field in which neglect to keep abreast of the times in research and training would be more disastrous. Notwithstanding the fact that gas was used in the World War two years before the United States entered the fray, practically nothing was done in this country before April 1917, towards the development of any chemical warfare appliances, offensive and defensive, and had it not been for the ability of an ally to supply our troops with such appliances, they would have been as defenseless as the Canadians were at Ypres when the Germans sent over their first gas cloud."

Due to the fact that no branch of the Service had any idea of the practical methods or import of gas warfare, it is not surprising that although the first American troops sailed for France in May 1917, it was not until 5 June 1917 that G.O. No. 8 AEF Headquarters outlined the establishment of a Chemical Warfare Unit. But it was not until 17 August that Lt. Col. Amos A. Fries was put in command of the 30th Regiment of the Corps of Engineers, to be known as "The Gas and Flame Troops." Whereas a Chemical Service Section for the United States was not authorized until 16 October 1917.

In the early days the concept of centralized, component or end-item procurement did not come into being. Instead, practically every branch of the Army had some connection with Gas Warfare. The Medical Corps was in charge of Gas Defense. Ordnance was charged with Gas Offenses. Signal Corps

Branch Chiefs in Engineering Division of New York District discuss set of drawings. Left to right: Mr. H. A. Wiener, Capt. George Katz, Lt. Howard N. Blitman, Mr. F. Lightfoot, Mr. A. DeGoeta and Mr. J. Harris.

Major Ernest Marshall, a Reservist from Detachment No. 10 and Attorney in civilian life, discusses Renegotiation of Contracts with a group of civilian negotiators.

purchased gas alarm devices. The Engineers headed up the Field Training Section, while a civilian agency under the Bureau of Mines was in charge of the Research Section.

Just before Col. Fries took over as Chief of the AEF Gas Service, 20,000 American made copies of the British box respirators arrived in France. Field tests showed that the granules in the canisters were too soft, the charcoal of poor quality and most important, the rubberized cloth used in the facepiece was so permeable to gases, that in an exposure of less than one minute to chloropicrin, it became unbearable to the eyes. This was due to a woefully unrealistic appreciation by civilian planners of the extent to which an enemy will go to win a war.

Consequently, knowing the terrible toll the Germans took when they first used mustard, Col. Fries, the day after he took command, put through a rush order for 200,000 gas masks, 100,000 British make and 100,000 French masks for use by the American troops in France. This initial Chemical Warfare Procurement order was turned over to the Medical Department from which Col. Fries retrieved it to push it through personally. This action was understandable in that as no Gas Service had been organized in the continental U. S., no money had been appropriated for its operation and any weapons or supplies had to be obtained through purchases made by other departments handling the same equipment. In those early days, it was not only difficult to get another Branch of the Service to accept orders for Chemical material and get the process moving, but a follow-up was virtually impossible. Officers in other departments felt that once the requisition for supplies was turned in to them, the Chemical people should be patient. But this was impossible. General Sibert and Col. Fries were absolutely responsible for protective and offensive gas supplies, business-as-usual practices and channels had to be brooked irrespective of the friction and misunderstanding for each attack subjected the troops to a fresh or varying type of gas. This unworkable situation was solved by setting up a Chemical Warfare Service with the right of direct procurement. Formal orders covering this division were issued 13 July 1918.—3 full years after gas warfare began.

However, the lack of officer and enlisted personnel, orientated scientists and industrial concerns possessed of the know-how and capacity, to say nothing of a reluctance to engage in the manufacture of a dangerous war weapon by processes and equipment having little Post-War use, conspired against the first leaders of the Chemical Warfare Service to a degree that with the exception of gas masks and certain defensive supplies, no gas cylinders, mortars, projectors or artillery shells were received by our troops until just before the Armistice, despite the fact that great quantities had been available in the States for months. However, over 3,600 tons of gas in one-ton containers had been shipped to the English and French. Our Gas troops in Europe having no procurement and manufacturing department in the States worked under almost insurmountable handicaps.

The story of the Chemical Warfare Service in World War I was largely the story of the gas mask. It is a fact little known to many people today that material and parts were purchased for the production of 5,692,000 completed gas masks—3,614,925 of which were produced at Army's Gas Defense Plant at Long Island City, N. Y., while the remainder were assembled at the Hero Manufacturing Company in Philadelphia. The initial New York order was for 1,100,000 masks to be completed within a year from July 1917. How little this complicated problem of component and end-item procurement was understood in those days can be seen from the fact that one Major, two Captains, and ten Lieutenants were assigned to a program in New York which eventually consisted of 12,000 civilian employees! Experience soon showed that because of the need for extreme care in manufacture and inspection of the mask, the ordinary commercial organizations were not equipped to meet the standards of performance and delivery required by the Army. Consequently, on 21 November 1917 the Secretary of War authorized the establishment of the Army operated gas mask factory in Long Island City. This plant, according to the records of Mr. Randolph Monro, presently Chief of Headpiece Development Branch in the Protective Division, who was a Chemical Warfare non-Com in W.W.I, was located about four blocks from the Long Island City end of the 59th Street or Queensboro Bridge. Facilities were set-up for gas mask manufacture in the Ford Motor Co. and Goodyear Tire and Rubber Co. buildings which are still very much in use today. If one thinks that "Component Procurement" was a headache in W.W.II, let us briefly review Procurement in W.W.I. B. F. Goodrich Co. of Akron, Ohio, manufactured the face-piece, connecting hose, check and flutter valve and mouth-piece; the American Can Co. of Brooklyn, N. Y., produced the canisters; the Day Chemical of Westline, Pa., gave the charcoal its first burning; Ward Baking of Brooklyn gave it its second baking; General Chemical of New York supplied the soda-lime granules; the Doehler Die Casting of Brooklyn, the angle tubes; Simmons Hardware of St. Louis, the waterproof knapsacks; the Seaver Howland Press of Boston printed the "How-to-Use-it" cards! A tribute to those early Gas Officers in the New York District is the fact that they showed that military and civilians could work side-by-side, turn out a

(Continued on page 44)

Key Military Personnel of the New York Chemical Procurement Office. Seated, left to right: Maj. Pearl Weiss, Chief, Industrial Reserve Equipment Branch; Maj. Frederick J. Hurley, Chief, Procurement Division; Capt. John H. Eller, Executive Officer; Lt. Frances Berg, Asst. Adjutant. Standing: Capt. Joseph Lustig, Reserve Officer, Detachment No. 10; Capt. Pierre Gunder, Reserve Officer, Detachment No. 10; Capt. George Katz, Engineering Division; Capt. Myron M. Nagelberg, Procurement; Capt. Donald Calo, Small Business, and Capt. Malvin F. Glass, Comptroller. Col. Joseph Escude, Commanding Officer, was away at a plant when picture was taken.

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Air Reduction Company, Inc., New York, N. Y.
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New Smoke Generator

The Army Chemical Corps has developed a lighter and more mobile smoke generator for use in concealing troop movements and confusing the enemy.

The new device is know as the pulse-jet smoke generator, as it operates on the same principle as the jet engines used in aircraft. The new generator weighs only 150 pounds and is much simpler in operation than its 266-pound predecessor, the M-2.

This equipment can be carried by two men, although in combat it is usually mounted on a jeep trailer. To the field soldier, its outstanding feature is that no water is needed, in contrast to the M-2 smoke generator. It has only three moving parts, thus making it easier to operate and repair. The new smoke producer needs only two liquids, gasoline and fog oil.

The pulse-jet smoke generator was battle tested in Korea early in 1952 and found to be highly effective.

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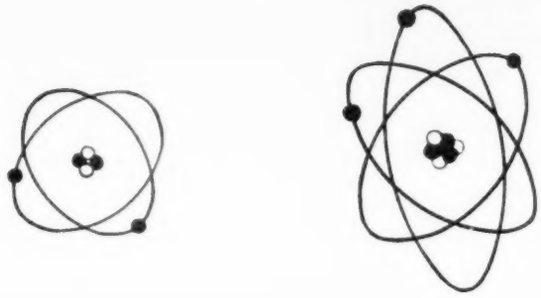
Atomic Energy



ITS HISTORY AND BENEFITS

By MILTON C. KURTZ
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In the history of scientific discovery, there are lessons which we must heed or the frustrations that attended other discoveries will repeat themselves in the study and development of atomic energy.

For instance, sulfuric ether was discovered in 1540. For over 300 years it remained a commonplace chemical, dangerously inflammable. It was almost unused though it was often employed playfully by college students as a brisk and potent intoxicant. It was 1843 before Long and Morton found and showed its wonderful value as an anesthetic. It often takes long years to make a substance that is known to science useful to man. Think of the sum total of unnecessary pain during 300 years of the failure to explore the effect of ether on man.

Gasoline—at first a worthless and dangerous byproduct of distilling kerosene from crude petroleum—was thrown away by the millions of barrels, until its value was shown when used in engines designed to turn its explosive energy into mechanical work. As a result of the internal combustion engine came the automobile, the tractor, and the airplane—long after gasoline was first produced and thrown away.

However, with energetic and alert study the gap between a discovery and its major application may not last long. Only 14 years elapsed between Fleming's discovery of the antibiotic effects of a common mold and the production of penicillin in significant quantities for use in human therapy.

Roentgen discovered X-rays in 1895. The immediate obvious application in the detection and correction of fractured bones was made rather promptly. Later in the use of hard X-rays upon tumors and soft X-rays upon the skin and hair, physicians found uses of X-rays not dreamed of by Roentgen or his contemporaries. Once a new substance is made, or a new process invented, years—even centuries—may elapse before all its properties or uses are discovered and put in practice.

The mention of atomic energy causes the average citizen to think in terms of atom bombs, super-hydrogen bombs, and invisible, deadly radiations given off by atomic explosions.

It is general knowledge that the first atomic bomb used in warfare immediately killed 40,000 individuals; another 25,000 suffered a delayed but sure demise. It is not general knowledge, however, that directly or indirectly atomic energy has benefited the lives of many people. The purpose of this article is to give a history of events leading to the development of the atom bomb and to give some of the benefits which have been derived from atom bomb research.

In 1895 Roentgen discovered that a shower of electrons on a metal target caused the metal target to emanate very penetrating radiations. Roentgen called this X-rays. A year later Henri Bequerel found that uranium salts emitted penetrating radiations similar to those discovered by Roentgen. These salts which emitted rays were said to be radioactive. The tremendous importance of this discovery was not immediately apparent. However, a few years later Pierre and Marie Curie gave added stimulus to the investigation of a new field by announcing that they had succeeded in isolating from pitchblende a uranium mineral, two substances that were many times more radioactive than uranium. These substances were shown to be two new elements, polonium and radium. It is important to emphasize that these radioactive elements emit radiation spontaneously without the addition of energy to them.

The world's most skillful physicists worked for a period of several years before they were able to identify the mysterious radiations emitted by the radioactive elements. Rutherford showed that some of the rays could be deflected by a magnetic field and thus separated from one another. It was shown at that time that the rays emitted are of three distinct types. Those most easily deflected by a magnetic field are called beta particles. Those deflected only slightly are called alpha particles and those unaffected by the field are called gamma rays.

From the fact that the alpha particles are deflected perpendicularly away from a magnetic source, it is known that they must be positively charged particles. By similar reasoning, the beta particles must carry a negative charge, and the gamma rays must be uncharged or electrically neutral.

Having thus investigated in a preliminary way the electrical nature of the radiations, let us consider the penetrating power of each. The alpha particles are stopped by a few sheets of ordinary paper, but the beta and gamma rays pass through appreciably undiminished in intensity. A few millimeters thickness of aluminum sheet will stop both the alpha and beta particles, but again the gamma rays are only slightly reduced in intensity. Finally, a few centimeters of lead will absorb all the alpha and beta particles and greatly reduce the gamma-ray intensity but still does not absorb all the radiation. We may summarize the properties of these radiations as follows:

Experiments have shown that an alpha particle carries a positive charge equal to exactly twice the electron charge. Furthermore it had a mass equal to that of a helium nucleus and, in fact, has been shown to be exactly that.

Subjecting beta particles to the influence of an electrostatic field, shows that they have an electrical charge equal

to that of the electron and that they also have a mass equal to that of an electron. Thus beta particles are simply high-speed electrons that result from nuclear disintegrations.

Gamma rays are electromagnetic photons identical in nature with X-rays. For the same wave length of radiation, the properties of the two rays are the same, the only difference being one of origin.

Experimentally, we know that two nuclear particles strongly resist any effort made to bring them close together. Because of a high potential barrier existing around an atomic nucleus, an incident particle must have a very high velocity before it can make a close collision and cause a nuclear reaction. This is the reason why nuclear reactions are so rare under ordinary circumstances. Atoms involved in chemical reactions rarely exchange more than a few electron volts of energy. Since such energies are small compared with energy levels of nuclear potential barriers, the particles never come close enough to cause a nuclear reaction to be induced. For instance, 12 Mev of energy are required of a proton for it to approach a lead nucleus.

Since natural radioactivity furnishes a simple source of high-energy particles, it is quite understandable that the earliest experiments in the field of artificial radioactivity were performed with this source. Shortly after Rutherford's early work in this field, physicists took advantage of another natural source of high-velocity particles, namely, the cosmic radiation, to observe new types of reactions. It was demonstrated later that protons could be artificially accelerated, and a new type of research was born. This field led to the development of the huge particle accelerators, such as the cyclotrons, betatrons, and van de Graff accelerators. These were the much publicized "atom smashers" of the last decade.

Researches in the field of induced radioactivity have led to the discovery of many new types of nuclear reactions. More important, from the standpoint of atomic energy, experiments in nuclear distintegration have resulted in the discovery of a particle called the neutron.

Neutrons were first produced in 1930 by bombarding light elements, such as beryllium and lithium, with alpha particles from a polonium source. This bombardment gave rise to a radiation far more penetrating than had been previously measured. In the process of passing through matter, neutrons may interact with the atoms and cause profound changes in the atomic structure of the matter acted upon. In fact, transmutation of the elements, an alchemist's dream, is now possible by neutron bombardment.

Shortly after the neutron was discovered, Fermi and his collaborators in Italy bombarded uranium with neutrons from a radium-beryllium source. After irradiation with neutrons, they found several activities induced in the element were preplexing because none of them corresponded with those of atomic number 86-92. It was eventually discovered that the uranium, under bombardment, had split into unequal parts. This process was termed fission. By this process of splitting up of uranium, two smaller fragments are produced that together weigh somewhat less than the original mass of the uranium nucleus. This disparity in mass is a real one and means that a considerable quantity of energy, roughly 200 Mev, is liberated in the fission process.

The discovery of fission stimulated great activity in the United States. This activity, begun in 1939 with the investigation of fission phenomena in almost every nuclear-physics laboratory, continued at an ever-increasing pace and culminated in the large scale release of nuclear energy, the atom bomb.

At the end of the war we found ourselves in possession of a two billion dollar investment in the huge secret plants that had gone into the making of the atom bomb. The Manhattan District of the U. S. Army Engineer Corps had constructed and developed the atmic energy project for one reason—to produce enough atomic bombs to bring the war to a successful and rapid conclusion. With the war ended, the fate of the atomic energy project hung in the balance. Roughly the assets of this project were, (1) facilities for producing atomic bombs, (2) potentialities for producing atomic power, (3) facilities for producing unprecedented amounts of radioactivity in a wide variety of elements, and (4) laboratories for pursuing fundamental and applied nuclear research.

A great benefit to mankind can be realized from one particular asset of the atomic energy project, namely, the facility for producing unprecedented amounts of radioactivity; for producing radioactive atoms or radioactive isotopes.

Radioactive isotopes, or radioisotopes for short, are nothing other than radioactive counterparts of ordinary stable atoms. The elements heavier than bismuth such as radium, thorium, and uranium exist in nature in radioactive forms; however, radioactive forms or radioisotopes of most of the lighter elements must be artificially produced. These radioisotopes look the same and act chemically the same as nonradioactive or stable forms of the same elements. For example, radioactive carbon behaves like ordinary carbon, radioactive sulphur like ordinary sulphur, etc. They are unique in one way. Over a period of time they will disintegrate and in so doing will emit rays which can be detected.

These two facts, first, that radioactive and stable atoms of the same element are chemically identical and second, that radioactive atoms in disintegrating emit radiations which reveal their location and identity, account for the extremely versatile and valuable applications of radioisotopes. Because of these properties, it is possible to use radioisotopes as tracer atoms; atoms which will "give away" where they go even in the most complicated systems and processes. Tracer atoms provide one of the most powerful tools yet placed at the disposal of scientific investigators.

Radioisotopes are not new; they were known and used over a decade before the advent of the nuclear reactor or atomic bomb. Man-made radioisotopes of most of the elements had been prepared in cyclotrons during the 1930's by bombarding the centers of nuclei of stable atoms with highly accelerated particles. The use of naturally occurring radioisotopes as tracers for earmarking the behavior of stable atoms dates back to the 1920's.

By 1940, radioisotopes had been used in a variety of research applications as tracers and even to a limited extent as both external and internal sources of radiation for radiation therapy. The major drawback to their widespread utilization at that time was that production was both limited and costly. Even with many cyclotrons the total amount of radioactivity produced was so small that the man-made radioactive atoms could be made available to only a few score of investigators. Yet, these prewar investigators had found radioisotopes to be extremely valuable and to give data which could be obtained in no other way. In fact, using radioactive atoms is like using atoms which are tagged with labels. No matter where the atoms are or in what reactions they take part, they can always be detected and identified by the radioactive label. It is possible to trace a particular batch of radioactive atoms through a complicated system even though they become mixed with many other stable atoms of the same element.

In addition to the unique ability which the radioisotope technique provides for following specific atoms, early investigators also found this method of analysis to be extremely sensitive. Depending on the particular isotope used and the nature of the investigation, the radioisotope technique is found to be many thousands to millions times as sensitive as ordinary chemical analyses. In some cases, one

can detect less than a billion-billionth of an ounce of the radioactive atoms.

During the wartime development of the atomic energy project it became evident to scientists who worked with a chain-reacting uranium pile that it would be an excellent unit for producing huge quantities of radioisotopes.

Radioactive atoms are produced in the pile by two different nuclear reactions, fission and neutron absorption. When a uranium 235 atom splits or fissions, it breaks into two radioactive fragments, each of which in turn disintegrates through several radioactive intermediates, finally ending up as a stable atom. These intermediate products, called fission products, are radioisotopes of elements ranging in atomic number from zinc (number 30) to gadolinium (number 69).

If we take almost any of the elements around us, such as, phosphorus, sodium, or iron, and we put it into an atomic reactor or pile, it can be made to become radioactive. For example, a penny, dime or piston ring, or any other variety of materials or objects, can be introduced into a reactor. These will then be subjected to a tremendous bombardment by neutrons. These neutrons, because they are uncharged are able to penetrate very easily into the nuclei of atoms. This addition of neutrons to nuclei results in the production of radioactive isotopes.

The chain reactor is able to produce radioactivity in amounts enormously greater than could be produced before the war by means of the cyclotron. The amounts of the various radioactive isotopes produced with the pile are thousands to millions and sometimes billions of times the amounts produced previously. Also pile-produced radioisotopes are to a certain extent byproducts of atomic research and development, hence they can be made cheaply. Although radioactive tracer atoms had been produced and used before the war, they were produced only in small amount and were expensive. Their use was hence quite limited. Atomic energy developments have now made these extremely useful tools actually available for research and application on a wide scale at low cost.

Armed with this background, let us now see how we use tracer atoms. Let us take for example radioactive sodium. All we have to do to make some radiosodium is to take some table salt and irradiate it in the pile. We could give some of the radioactive sodium to a person, and then by means of a Geiger counter find out how rapidly it travels throughout the body, and the rate at which it is taken into various body fluids and tissues.

We find for example that the rate at which sodium goes across the blood vessel walls is very rapid indeed. These studies have shown that sodium passes back and forth across the blood vessel walls at the rate of 50 pounds of salt a day. The rate of exchange of sodium (or any other element) back and forth across the blood vessel walls, or any other membranes in the body, could not be found by other methods because one could not tell the ordinary sodium atoms on one side of the blood vessel wall from those on the other side. However, by putting labeled sodium atoms on one side and observing the rate at which the labeled sodium atoms appear on the other, we can observe the rate of transfer of sodium.

The most rapid transfer of sodium in the body is by circulation of the blood. Only a few seconds are required for the sodium to go from one arm through the heart, through the lungs and into the other arm. It was also found that diffusion out into the tissues and even into the sweat glands is very rapid. In only 75 seconds after injection of the sodium in one arm, it starts being excreted from a sweat gland in the other arm.

Once the sodium tracer atoms have been incorporated into a system we can study the rate at which they are eliminated. By studying the uptake and elimination, we can obtain the rate at which sodium atoms are replaced or turned over in the system. It is found that in a week or two, half of the sodium atoms that are now in our bodies will be replaced by other sodium atoms. Similar experiments with tracer hydrogen have shown that hydrogen atoms in our body are also quite rapidly replaced, half of them being replaced also in a week or two. Likewise it has been found that half the phosphorus in us now will have been replaced in a few weeks, and half of the carbon atoms in a month or two, and so on for nearly all the elements in us.

One of the most widely used methods to date in studying cancer consists of purposely producing an experimental cancer in an animal and then studying the biochemistry of the cancer and its effect on the animal. There are hundreds of organic compounds which may be used as cancer producing agents. Radioisotopes may be used to label such cancer-producing agents and to study their mode of action. For instance, methylcholanthrene, one of these agents, has been labeled with radioactive carbon. A skin cancer is produced by repeatedly painting the labeled agent on the shaved skin of the animal. Some of the agent used in producing the cancer will be found incorporated in the cancer but some of it will have been broken down into other products. The location of the agent and its breakdown products can be studied not only in the cancer but in all the other tissues. Studies of this type will broaden our over-all knowledge of cancer and the more we learn about the peculiarities and characteristics of this disease, the better equipped we will be to combat it.

Not only are radioactive tracer atoms being used to help ferret out the intimate and complex biological processes of life—in gaining new medical knowledge—but they are also being used to ascertain what is wrong with certain body processes, that is, to diagnose disease and injury.

Radioactive sodium for instance may be used in the diagnosis of various blood circulation disorders. If a labeled salt solution is injected into a normal person, the circulating blood will quickly and equally distribute the sodium to both legs. We can learn this by moving a Geiger counter up and down each leg and finding approximately constant radiation readings. On the other hand, if the counter indicates an absence of radioactivity in a certain area, say the left lower leg and foot, it shows that the blood has not carried the radioisotope to that area and, therefore, there is an impairment of the circulation. A survey with the Geiger counter will localize the area of the impairment or constriction. This diagnostic technique has proved so reliable that it has been used to determine whether or not it is necessary to amputate and if necessary where to make the amputation.

Radioactive sodium is used in still another way as a diagnostic tool. In this instance the purpose of the diagnostic technique, known as radiocardiography, is to determine the pumping qualities of the heart by recording the passage of radioactive blood through the chambers of the heart.

Radioactive sodium is introduced into the vein of the patient's arm, from whence it goes directly to the heart. a radiation detector connected to a special ink-writing recorder is placed outside the body over the heart. When the radioactive sodium enters the chambers of the right side of the heart, the radiation picked up by the detector causes the recording pen to rise sharply. The pen continues to rise in the case of a normal heart for about one second and then starts to drop back to the zero line as the labeled blood moves out of the righet chamber into the lungs. After two to four seconds, however, the labeled blood will start entering the left side of the heart and once again the recording pen will rise but not as sharply and not to such an extent as in the first instance. As the labeled blood moves out of the left side of the heart and out into the body, the recording pen will again fall back to the zero line. In this way,

tne pumping action of the two sides of the heart can even be individually studied. The shape of the curves produced indicates whether the heart is functioning normally. If the curves are irregular in shape, they may indicate the type of heart disorder.

This diagnostic procedure has been carried out in over 400 patients and has already proved helpful in the diagnosis of a number of heart conditions. In some cases, information has been obtained which could not be determined by other means. The procedure subjects the patient to no discomfort, is completed in a few minutes and to date has shown no ill effects on the patients. The method is, however, still in the experimental stage and has been tried by only a few investigators.

The most widely used diagnostic application of radioisotopes is the use of radioiodine in determining thyroid gland conditions. The thyroid gland takes up practically all of the iodine absorbed in the body. This is because of the gland's production of an iodine containing hormone called thyroxine. If the gland is overactive, its production of thyroxine is large and accordingly its ability to take up iodine is large. Underactivity of the gland produces the opposite effect.

These conditions with such different rates of uptake of iodine can easily be diagnosed by using test doses of radioiodine. The radioactive iodine need be administered only by mouth as a simple compound, sodium iodine. Since radioiodine gives off penetrating rays, its rate of absorption in the thyroid gland may be determined by placing a Geiger counter on the neck outside the gland and noting its response. Comparison with response of a normal person indicates the underactivity or overactivity of the gland.

Radioiodine is also useful in looking for offshoots of some cancers of the thyroid gland. Sometimes those offshoots are hidden in the lungs, brain or bones. If the cells of the cancer offshoot still have the ability to make thyroxin, they will take up radioiodine. The offshoots may then be located with a Geiger counter.

Radioiodine has recently been used for locating brain tumors. It has been known that a dye called fluorescein is selectively absorbed by tumor tissue of the brain. Since the dye is fluorescent it has been used to a certain extent to aid the surgeon in locating the tumor mass during surgery. The fluorescence technique is, however, limited because it can only be used after an incision through the skull. More recently, radioactive iodine has been incorporated into a similar dye, diiodofluorescein, which is also absorbed by tumor tissue of the brain. Now, however, since the radiations given off by radioiodine are penetrating enough to come through the skull, the diagnosis does not require an incision. About two to four hours after the radioactive dye has been injected into an artery loading to the brain, a careful survey is made of the patient's head with a Geiger counter. The surgeon then makes his incision to remove the tumor at the point where he finds the highest radiation reading.

Radioactive phosphorus has also been used as an aid in locating tumors. For example, radiophosphorus is absorbed more rapidly by the brain tumor than by the normal brain. Radiophosphorus cannot however be detected through the skull because its radiations are not penetrating enough. It is hence limited to use during surgery. This is valuable nevertheless for determining the exact extent of the tumor mass, especially of a deep-seated tumor, because other methods usually give only the tumor's general location. After the surgeon has made an incision he can probe around with a tiny specially built Geiger counter and determine the exact location and extent of a tumor below the surface of the brain. If future trials prove as successful as preliminary results indicate, this technique may become very valuable because it is quite difficult to tell the difference between normal tissue and tumor tissue during brain surgery.

These are examples of some of the better known diagnostic applications of radioisotopes. Future extension of the use of radioactivity in diagnosing disease will depend on the progress of finding compounds which can be labeled and which will selectively go to certain tissues and organs of the body.

Radioisotopes can also be used in larger doses—hundreds to thousands of times greater than the harmless tracer doses—to deliver radiation to diseased tissue. The greatest need for treatment of this kind is in controlling cancer and allied diseases. Surgery is often not suitable because it is impossible to get to or remove all of the diseased tissue. Neither X-ray nor radium treatment is always satisfactory because they have to be used from outside the body and it is difficult to direct their radiations to a localized area. For the same reason radioisotope treatment is not satisfactory in most cases. There are, however, a few notable exceptions.

Possibly the simplest illustration of radioisotope treatment makes use of local applications of radiocobalt. When cobalt is radioactive, its radiations are very similar to those of radium. If the malignant growth to be irradiated is on an external or easily accessible part of the body, either radioactive cobalt or radium may be used to deliver tissue-killing radiation. Radioactive cobalt, is however, much cheaper and in some cases more advantageous to use. It can be machined into any desired shape or size before being made radioactive and used in more flexible ways than radium. This application is however based entirely upon mechanical placement of the radioisotope as in radium treatment, and therefore makes no unique application of the properties of the man-made radioisotopes.

Radioactive gold is being used to treat cancers situated near the body surface. The radiogold is put into a special colloid. The colloidal gold is injected uniformly throughout the cancer mass so as to bombard all the cancer cells with radiation. Radiogold administered in this way does not enter into any of the body processes but stays localized in the area into which injected. Here again, the placement of the radioisotope is entirely mechanical. Advantages of this type of treatment are that the site of irradiation can be localized, the radioisotope can be easily administered and there are no seeds or needles to extract when the treatment has been completed. This type of treatment is, however, still in the experimental stage.

A more representative illustration of the unique application that can be made of man-made radioisotopes is the use of radioactive phosphorus in treating polycythemia and chronic leukemia. Polycythemia is a condition of overproduction of red blood cells whereas leukemia is an overproduction of white blood cells. Radioactive phosphorus is useful in treating these blood diseases because to a limited degree it is selectively absorbed by the bones where the overproduction of blood cells is taking place. The radiophosphorus may be given to the patient by mouth in a simple sodium phosphate solution. The radiations given off by the isotope are not very penetrating; thus the tissues in which the radiophosphorus localizes obtain the most radiation. Extended long range damage to the bone marrow is prevented because radiophosphorus is not radioactive for long, yet the irradiation is extended sufficiently long to inhibit blood cell production. This treatment has been established by many physicians as the treatment of choice for polycythemia. It has also been used with considerable success in treating chronic leukemia but has not proved successful in treating acute leukemia.

Certain disorders of the thyroid gland are especially suited to radioisotope treatment. This is true because, as pointed out earlier, the thyroid gland has a particularly keen appetite for iodine. Here we are using the chemical behavior of the radioisotope, rather than mechanical placement, to achieve the desired localization. Radioiodine is

used for treatment in the same way it is used to diagnose thyroid disorders except that several hundred times as much isotope is given to the patient. Of course, this kind of treatment is not started until a tracer dose of iodine has first been used to diagnose the trouble and to determine that a large dose will benefit the patient.

Radioiodine has, for instance, been found to provide a simple, effective and apparently safe method for treating patients with hyperthyroidism. Most cases of hyperthyroidism are controlled in two to four months by one or two treatments. Certain types of goiters disappear after treatment whereas other types only become smaller. Radioiodine is also used in treating certain kinds of thyroid cancer and its offshoots. Some cancers of the thyroid gland do not take up sufficient radioiodine for successful treatment. Radioiodine has, however, proved useful in controlling selected cases of thyroid cancer. It should be noted that treatment with radioiodine or any other radioisotope has not produced a permanent cure of cancer of the thyroid gland or of any other body organ. Treatment consists of attempting to control the disease and to prolong the useful life of the patient. In this, radioisotopes have sometimes been successful.

Thus far we have dwelled entirely on ways in which radioisotopes have been put to work in trying to improve our health and to save us from disease. This emphasis is natural because the protection and improvement of our health is a matter of such personal and immediate interest to us.

The bigger problem in the world today, however, is in saving people from want and hunger. For as surely as we lengthen man's life span and free him from disease, we have more people to feed, to clothe and to house. This means that as we increase the world's health we must also find ways to increase the world's productivity.

Radioisotopes have become an extremely useful tool in studying the efficient use of fertilizers. One of the very important groups known as phosphate fertilizers can readily be studied with radiophosphorus. Here again a radioisotope provides a way of following a certain batch of atoms. The radioactive phosphorus is incorporated in the fertilizer which is added to the soil being studied. Later, radioactivity analyses of the plant show what parts of the plant have taken up the radioactive atoms and hence the fertilizer. Chemical analyses of the plant indicate the total amount of phosphorus coming from the fertilizer plus that coming from the ordinary phosphorus previously present in the soil.

Experiments have also been conducted by placing plants in an atmosphere containing radiocarbon. By determining the amount of radiocarbon and the chemical compounds in which it is contained, deeper understanding of the fundamental processes of photosynthesis is being obtained.

From such studies, investigators can determine not only how much phosphorus is taken up by a plant and where it came from but also the efficiency of the fertilizer, the best type of fertilizer to use and the best place to locate the fertilizer with reference to the location of the plant. More efficient ways of using fertilizers are being found for each type of crop and depleted soil.

It has been found that very small amounts of certain metallic elements such as cobalt, copper and zinc are necessary to animal diet. Cobalt, for instance, is a necessary element in the cow's diet. At present, areas seriously deficient in cobalt and therefore sites of serious livestock malnutrition have been reported in Florida, Michigan, Massachusetts, Wisconsin, New Hampshire, and North Carolina as well as in New Zealand, Australia, New South Wales, Africa, the United Kingdom, and Canada. When cattle are fed on forage containing less than 4 parts of cobalt in one hundred million, they lose their appetites and literally starve to death although surrounded by a luxuriant growth of pasture. On the other hand, horses placed in the same pasture remain in excellent health. The problem until recently has been complicated by the fact that the amount of cobalt in the blood and tissues of the animal is so small that chemical analysis is inadequate to diagnose the condition. Recently radioactive cobalt has been used in investigating this problem. The radioisotope technique is sensitive and reliable at these small concentrations. It also allows the fate of cobalt in the physiological processes to be followed. Cobalt appears to be essential in the bacterial processes of digestion which go on in the rumen of the cow (also of sheep).

But the world's standard of living is dependent on more than food productivity alone. To increase this standard of living we must also improve the productivity of other useful materials and goods. Here is where industry enters the picture. Indeed, continually advancing standards of living can only be achieved by the increase of both industrial and agricultural productivity.

Radioisotopes have not been used as extensively in industrial research as in other types of research; however, the list of important uses is growing daily.

The isotope dilution test and activation analysis are good examples of the industrial use of radioisotopes. The method used in the isotope dilution test parallels that which might be used to estimate the number of white beans in a five-gallon jar. The estimator could throw a hundred black beans into the jar, mix the contents thoroughly, and then take a random sample. If the sample contained two black beans and a thousand white beans, he could estimate that there would be 500 times as many white beans as black beans.

An interesting study has been in the field of metallurgy and is concerned with how atoms move about in solid metal. Metallurgists have long thought that the atoms even in solid metal tend to move around or diffuse but there wasn't any way of accurately measuring this. A radioactive copper block and a nonradioactive copper block were clamped together and baked at a specified temperature for several hours. The two blocks were baked because according to theory, atoms should move around more readily as the temperatures are increased, even though such movement would still be almost infinitesimal. The blocks were cooled and again taken apart. Sure enough, radioactive atoms were found in what originally was the non-radioactive block. Of course, the radioactive atoms were concentrated near the surface which had been next to the radioactive block but some of them have moved further into the block.

One limitation to the use of radioisotopes in testing industrial products is the possibility that some of the radioactivity will be left in the finished market product. This might be dangerous to the consumer as well as to other people who handle the product before it gets to the consumer. For this reason distribution of radioisotopes for use in industry has been primarily limited to laboratory scale research problems.

One radioisotope research investigation which may pay dividends within the next few years is the study of wear and lubrication. A piston ring is sent to Oak Ridge, made radioactive in the pile and then returned for placement in an engine. The motor with its radioactive piston ring is then run. As the ring wears, some of the radioactive atoms will get into the oil. Periodic sampling and radioactivity analysis of the oil lubricant will show just how much the ring is wearing away by friction. Also after the run has been completed a photographic film may be placed against the inside surface of the cylinder wall. Radioactivity which has been transferred to the cylinder wall will expose the photographic plate and show the regions of greatest wear.

These studies can accurately determine one-millionth of an ounce of metal transferred from the ring to the oil. Tests that previously required several weeks can now be done

SOLDIER PLACEMENT SERVICE

The Scientific and Professional Placement Service, an activity of enlisted technical personnel assigned to the Army Chemical Center, has submitted its first progress report since its organization in the spring of this year.

The purpose of the service is to aid Chemical Center soldiers who have technical backgrounds, either educational or professional, to find employment after they are released from active duty with the Army.

A survey of personnel using the Placement Service indicates that approximately 180 of the 220 Scientific and Professional Personnel scheduled for release between now and the end of the year have utilized the service and arranged interviews with one or more of the participating companies.

The Service, which is actually a committee of the Enlisted Specialists' Chemical Engineering Club, invites leading companies and representatives of government services to interview technically trained personnel who will soon return to civilian life.

Those companies which express interest in the service, but cannot be invited to the Chemical Center either for reasons of size, limited interest to the group or lack of facilities for holding interviews are invited to send literature and application forms for interested personnel.

Pfc. Eric Kjellmark of Scarsdale, New York, one of the soldiers who works on the Scientific and Professional Service at the Army Chemical Center, Maryland, talks to another soldier about a possible future civilian career with one of the many firms and government agencies that use this soldier-operated service.

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with more accuracy in a few hours to a few days. Such studies should eventually lead to the production of better lubricants as well as to better design of diesel, automobile and airplane engines. Similar studies are being conducted with ignition systems, automatic transmissions, and new brake system designs.

About the only way in which radioisotopes have been used in controlling industrial production thus far has been in the gauging of thickness. The radioactive thickness gauge depends on measuring the amount of radiation originating from a radioisotope source which will penetrate the material to be gauged. The instrument which detects the radiation is connected to a radiation meter which may be designed to read in thickness values. Of course, the amount of radiation passing through the material is dependent on the thickness of the material. The radiation detector is able to determine small differences in radiation and therefore small differences in thickness.

The radioactive thickness gauge is particularly valuable because it is very sensitive to small differences in thickness, because it gives reproducible results, because no contact involving the possibility of tearing or marking is made with the sheet being measured, and because a great range of thicknesses may be measured by merely changing the radioisotope to give the desired type of radiation. This thickness gauge may also be used to measure a continually moving sheet of material. As an added feature, though it is not in operation as yet, the gauge may also be used to control the rollers to regulate the thickness of the sheet material during production.

Clogged or partially clogged pipelines are a continual headache to the companies which manage the huge network of transcontinental pipelines. By attaching a radioactive source to their pipeline scrapers, oilmen can now follow the progress of the scraper through the line. In event of blockage, the obstruction can readily be located by detecting the radiations given off by the radioactive source on the stalled scraper. Truly, man has achieved for himself the dream of decades, X-ray vision.

These examples are typical of some of the ways in which radioisotopes have been used in the applied phases of industrial research. They are not indicative, however, of some of the less well-known applications in long-range industrial research problems nor are they indicative of the many potentialities of radioisotopes in industrial research.

Radioisotopes are, for instance, even now being used in other investigations covering such a scope of topics as vulcanization, polymerization, corrosion, catalysis, well logging, organic synthesis, flotation, etc. In recent months many more industrial applications have been suggested for these valuable and versatile research tools. Indeed, there is every reason to believe that within the next few years with additional trained personnel and with an additional number of industrial consulting laboratories offering services to prospective industrial users, industry will find as many and more uses for radioisotopes as have the fields of biology and medicine.

We have been considering radioisotopes as important benefits of atomic energy. Other benefits of immeasurable value will certainly come from the development of useful atomic power and from research in atomic science.

We must realize, however, that this is an inference. What we infer is that since atomic energy developments and applications can be used to make people healthier, increase their productivity, and relieve their material wants, people will live better lives and be happier.

MOST USED TARGET

"Most heavily bombed spot on earth" is the title claimed for a five-acre patch of real estate owned by the U. S. Army Chemical Corps in the woods near Pine Bluff, Arkansas.

The claimed title-holder is a circular mat of concrete roughly the size of four football gridirons. It is used by the Chemical Corps for the testing of incendiary bombs manufactured at its Pine Bluff Arsenal. Out of each batch of bombs produced, a certain percentage are tested by dumping them on the target. Not all the bombs hit the target, but at least some out of each lot must hit before the Chemical Corps inspectors will approve the lot. It has been estimated that since the target was built in 1943 at least 400,000 bombs have hit it, enough to give it "more pock-marks than not."

That many bombs would cause a lot of fires over a city area. (In 1945, an incendiary raid was aimed at Oita, a hitherto unbombed modern city of 61,500 people in Japan. Although it had been raining steadily for a week before the raid, and the city's civilian defense forces had been forewarned, the bombs wiped out more than a fifth of the built-up section of Oita.)

The incendiaries are dropped from high altitudes in a pattern slightly larger than the target. A good hit will cause from 60 to 70 fires on the concrete. The rest burn out in the swampy woods adjoining the mat.

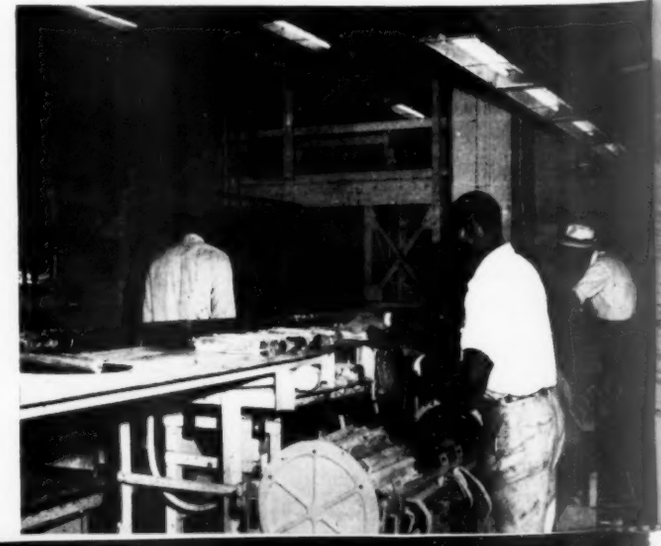
The bombs themselves barely nick the concrete, but in burning at a high heat, they cause the moisture in the concrete to turn to steam, which causes a small blast that blows a hole in the concrete.

At one side of the target is a 20-foot high concrete wall that has taken an even worse beating than the circle itself. It was used as a test target when "skip-bombing" was in its heyday during the war. It has suffered several thousand hits.

The bombing is carried out by an Air Force test squadron attached to the Army Chemical Center at Edgewood, Md., but operates out of an air base near Little Rock, Ark., 35 miles away from Pine Bluff. During the war, test bombings were made almost daily, but now the runs average about one a week. The Chemical Corps expects a certain percentage of duds in every batch of bombs produced, but feels that it is better to find out about a faulty lot in Arkansas than over a foreign target.

Pine Bluff Arsenal workers loading incendiaries into clusters. The clusters are dropped from planes to check the functioning of test groups of bombs taken as samples of larger batches.

—U.S. Army Photo



A single medium-sized white phosphorus bomb bursts against the concrete test wall at Pine Bluff Arsenal, demonstrating its potency as an anti-personnel, smoke screening and incendiary munition.

Not much chance to save this attic from destruction by fire. Above photo of a test, shows what happens when some of these incendiary bombs crash through the roof of a building.

—U.S. Army Photo

A cluster of incendiary bombs has just hit the test mat at Pine Bluff Arsenal. Photo graphically shows they are covered by these small bombs when dropped in a cluster.

The pock-marked concrete testing mat shows the hard usage to which it has been put in the last nine years as the Chemical Corps tests samples of its light incendiary bombs at Pine Bluff Arsenal.

During World War II, the above scene was re-enacted at hundreds of airfields throughout the world as the Axis nations felt the searing heat of these small, but extremely effective bombs. Above photo was taken in England during World War II.

BOMB PROOF SHELTERS

By
VICTOR DORKOVICH

In total warfare, such as we face, one of the prime objectives for enemy attack is the key personnel of the nation's government and military command, i.e., Chiefs of Military staffs; executive offices of Federal and State governments and the Congress itself. It is hardly arguable that the simultaneous annihilation of the Chief Executive and of the other key officials cited would instantly paralyze the nation's capacity to defend itself and indeed to carry on its basic economic activities, in view of the swift destructive power of modern warfare. The authority and tested experience of such men represent the very heartbeat of the nation, although in actual numbers they are comparatively few. Now, there exist no insuperable difficulties in the way of ensuring, no matter how many of the rest of us must perish, that these key men be preserved, to carry on the national defense, and to wage retaliatory war against the aggressor. This article suggests how such shelters may be provided.

The first thing to be considered is, from what specific dangers must these precious lives be safeguarded and what degree of protection should be extended in each case? The following table gives an estimate of the protection afforded from each type of hazard and every known kind of attack. It should be emphasized that at present we have full and reliable data only for attack by conventional High Explosive bombs. A great deal of information is now available regarding the effects of A Bombs, but this is mostly "top-secret," and not available for public use. Finally, aside from the fact that it is not yet known whether it is feasible to make an "H" bomb, there are only purely theoretical considerations to guide us. In the table the various hazards are listed roughly in their probably lethalness, together with an index giving the estimated degree of protection one might expect:

The WORST CONDITIONS ARE ASSUMED: NUCLEAR BOMB EXPLODES DIRECTLY ABOVE THE SHELTER, or in the case of a BLOCK-BUSTER H. E. BOMB A DIRECT HIT IS SUSTAINED.

	H Bomb	A Bomb	H.E. Bomb
Primary Effects			
1/Air blast	?	100	100
2/Flass burns	100	100	100
3/Gamma rays	100	100	100
4/Earth shock	?	80	100
5/			
Secondary Effects			
5/Collapse of the shelter:			
a) direct crushing and/or injury from flying objects, but no burial	?	100	100
b) as above but all exists buried with debris creating threat of: asphyxiation; death from lack of food or water	?	80	100
c) all exits deeply buried under debris, shelter structure intact	?	100	100
6/Fire:			
a) Originating within the shelter	100	100	100
b) Encroaching from outside	100	100	100
7/Poison Gases	100	100	100
8/Bacteriological Attack	100	100	100

The above is based on means for providing complete isolation from the outside world and the maintenance of normal facilities and physical needs for 7 days after "battening down hatches."

Out of their dire experience under saturation area bombing during the last war, the British have developed a new branch of applied statistics for appraising casualty risks and for preparing appropriate defense techniques for minimizing them. One of the most useful concepts has proved the "Unit Area of Vulnerability," which is the yardstick they use for determining the casualties—dead or wounded—which are probable under any given situation, wherein the density of population, types of shelter available are known and the caliber of the bomb or rocket can be anticipated. This Vulnerability Unit is rated on the basis of the average density of the population being one per 5000 square feet of area, being subjected to an average bomb-tonnage of one ton of high explosive. Further, it is assumed that if all the individuals in that area have equal Vulnerability coefficients, then the probable number of casualties for that area will be P x V (where P: the population and V: the average coefficient of vulnerability). From their many years of actual experience under H.E. bomb attack, it has been determined that in the event of a direct hit scored on a shelter, into which the bomb succeeds in penetrating, the probable casualties will be 80 per cent; whereas with only a "near miss"*, the casualties will reach an average of 40 per cent. A formula has been developed from which the probable extent of casualties for a given type of shelter can be predicted with uncanny accuracy:

Cp: 2000/W (0.8 A plus 1.6 DxA plus 1.26 D^2)

where C: Probable Casualties; W: assumed tonnage of

Figure 1

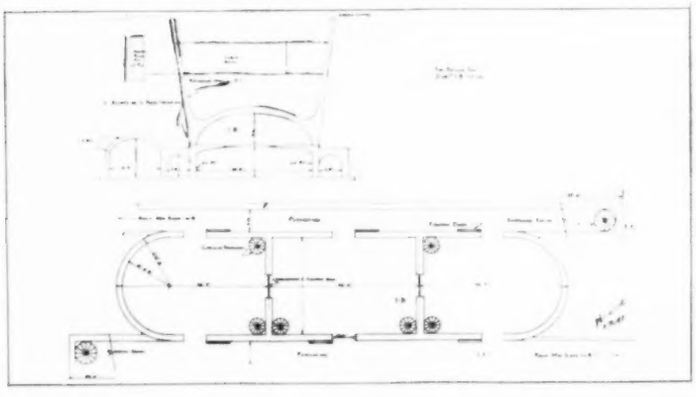
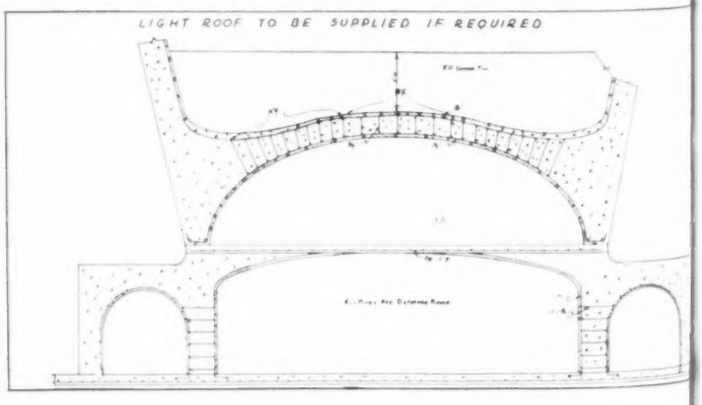


Figure 2



bombs dropped; A: area of the shelter; D: distance from the shelter wall considered as a "near miss" (see foot note)

*A near miss must be defined in terms of both proximity and of the structural strength of the shelter itself, i.e.: materials used; method of construction and massiveness. Thus, for a 12" thick, reinforced concrete wall, the bomb has to drop within 12 feet, to be considered a near-miss; with 24" walls, the distance drops to only 4 feet, dramatically demonstrating how effective properly designed shelters can be.

British practice is to rely as much as possible on dispersion for safety, which, of course, varies in inverse proportion with the coefficient of Vul- rability for the area. In other words, given a certain density of population, the smaller the area coefficient is, the greater the odds become that any individual will be within fatal proximity to the point of incidence of the bomb. For this reason, it is always advisable for large shelters to be sub-divided into compartments, each of which constitutes a separate shelter. Even, with their Class I shelters, the British took care during the war that no compartment exceeded 700 square feet in area.

From the foregoing, it is clear that no "complete" protection can be provided by a shelter that cannot withstand the heaviest type of missile in existence. There are two ways in which such shelters may be built: by going deep enough underground or by putting them in the basement of a modern steel-frame multi-storied building. Experience proved that even the heaviest block-buster could not penetrate more than the top 6 to 10 floors of such a structure. In this article, there is described a shelter to accommodate in some central location all of the key personnel of such administrative and executive organizations as are vital to repelling and destroying the enemy. Figures 1 and 2 show the plan and elevation of a three-compartment shelter capable of giving complete safety to 700 essential persons and the staff necessary for the proper functioning of the shelter and its complex mechanical plant.

Principal features are:

a) Utilization to the maximum of the natural protection afforded by the ground, by lowering the shelter roof well below the surface.

b) Use of steel nets and a thick layer of shock-absorbent material to minimize and/or ward off missiles scoring "bulls'-eyes" or the blast wave of a H.E. or A bomb fused to explode directly overhead.

Four distinctive protective zones are provided:

1) The roof of the shelter structure will be of heavily-reinforced concrete, 2 feet thick at its crown and designed as a bridge ring, capable of bearing a uniformly distributed load of several thousand pounds per square foot. This is far in excess of British recommendations which call for 350 lbs./sq. ft., debris load in case of caving and collapse.

2) Above the roof of reinforced concrete, there will be a 10 foot and up layer of some porous light non-flammable material to serve as a cushion for the stupendous air blast that a nuclear bomb would generate, if detonated immediately overhead. It is believed that a 10-20 foot thick bed of slag, coke, etc., would be adequate.

3) Above this should be provided one or better two powerful nets made of inter-woven heavy steel cables, which are to be firmly anchored by heavy concrete blocks buried deep in the sides of the excavation containing the shelter. The meshes should be about 12" square and be of one inch diameter cable. There should be left an interval of approximately ten feet or more between the top of the porous bed and between the nets, in order that the full benefit of their resilience may be obtained. In the course of being ruptured or collapsed by debris or explosion thousands of ton-feet of energy will have been absorbed, leaving the thick porous bed to absorb such residual force as will be left.

4) Unless the shelter is placed underneath a tall steel-frame building, a great pit will have to be dug. This will require some kind of a roof or rainwater will eventually form a pond above the shelter—an obviously dangerous and undesirable thing. Any light roofing construction will do, except that it should lend itself readily to being camouflaged. The latter should be so realistical that even all the points of entrance and of traffic approach should be undetectable in infra-red air reconnaissance or other means for distinguishing between natural vegetation and artificial covering.

The drawing shows one arrangement that would normally be best. However, considerable alterations in the details of the layout would be required to meet local conditions. Furthermore, it would be only in very special cases that such a large concentration of key personnel would have to be protected en masse. In most cases much smaller shelters with a capacity of not over 150 persons, spread over three separated compartments would be adequate. On the other hand, it would not be economical to build shelters of much smaller size since the cost of the mechanical installations required for the emergency operation of the shleter under "submerged" conditions, would rapidly grow prohibitive. An even more serious disadvantage would be the difficulty of finding enough of the highly trained staff needed to operate the plant.

FACILITIES: In order to furnish its occupants with "complete" protection as defined in Table I, it will be necessary to make it possible to stay completely isolated from the outside for a duration of say—seven days. During this period, there must be provided normal pleasant atmospheric conditions, i.e.: an average temperature close to 70° F., with a humidity of around 50 per cent; hot and cold running water, ample for both cooking and bathing. A well stocked cafeteria, capable of feeding the entire population at three sittings should be provided. The upper of the two main levels is intended for the dormitory, bathhouse and toilets. 250 comfortable bunks arranged in tiers of three high will permit every occupant to get his 8 hours 'rest, on a three-shift basis. The lower or main floor level has an aggregate area of 5000 sq. ft. plus or 7 sq. ft. per person.

SPECIAL FACILITIES include:

1) A duplex PX system connected with the outside telephone lines.
2) On "inter-com" system for internal communication and control.
3) Powerful two-way radio sets in duplex.
4) Periscopes permitting observation of the surface in the immediate vicinity.
5) Offices fully equipped for operating the shelter and to permit the occupants to carry on those important duties of command and administration as their official responsibilities may demand. Therefore, in addition to the usual desks, filing cabinets etc., there must also be available, equipment for the filing and display of large scale maps reference libraries, microfilm viewers, slide projectors, etc.
6) A small hospital and dispensary, complete with operating tables, X-ray machines, a dental chair, surgical beds, etc.
7) Recreation and rest rooms containing a moving picture projector, lecture-room supplies, a library and reading room; several sound-proofed rooms for the individual listening to gramaphone records and tapes.

ENGINEERING—The foregoing facilities, for their functioning, require an intricate engine room, not unlike that of a large submarine. This is too technical a subject to be discussed in this article, but it may be of interest to give a list of the major units that are required. All of the basic units, of course, must be duplex, in order that a continuous function-

(Continued on page 52)

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HISTORY OF THE NEW YORK CPD

(Continued from page 31)

mask that could meet all functional specifications and combat requirements and still be produced for 50 cents less per mask than those manufactured under contract. While the first shipment of the box respirators did not leave New York until 4 March 1918, production mounted until a peak of 43,926 masks for one day was reached on 26 October 1918. Under the provisions of G.O. No. 62, W.D. 28 June 1918, a request was made transferring the Headquarters of the Office of the Gas Defense Division, Chemical Warfare Service, formerly the Field Supply Section, Medical Department from the Surgeon General's Office, 7th & B Sts., N.W., Washington, to the Berkeley Bldg., 19-23 West 44th Street, New York City. This move was made to centralize the control at a point in close co-ordination with the plants engaged in production of masks and procurement of material necessary to their manufacture. Nevertheless, in retrospect, the accomplishments of the first C.W. officers were outstanding. Starting from scratch, this handful of men undertook to educate, train and protect the entire United States Army both abroad and in the States when it engaged a scientifically strong and resourceful enemy who just introduced the newest and most effective weapon of war since the introduction of gunpowder. Then, due to the resourcefulness and devotion to duty whether on the battlefield, in a procurement office or production plant, the C.W.S. intended as a temporary wartime agency, was set up as a permanent Branch of the Army by the National Defense Act on 4 June 1920 with Brig. Gen. Amos A. Fries as its first permanent chief.

Shortly after the Armistice, the newly established Edgewood Arsenal, twenty miles east of Baltimore, Maryland, was selected as the permanent home of the C.W.S. and all outside activities were rapidly terminated. Among those were Government operated and contract facilities in Long Island City, Bound Brook, N. J., Stamford, Conn., Hastings-on-Hudson, N. Y., Niagara Falls, N. Y., Buffalo, N. Y., Charleston, W. Va., and Croyland, Pa.

Then, after the establishment of the Service on a permanent basis and an evaluation of the lessons learned from a lack of awareness of the efficacy of Chemicals in war and of lack of preparedness so evident in the delays encountered in locating and setting up Government and commercial production centers in World War I, it was decided to set up on a "ready reserve" basis, field procurement offices under the direct supervision of the Procurement Planning Division of the Office of the Chief, C.W.S. War Dept. Bulletin No. 14, dated 17 August 1923 authorized establishment of procurement districts in New York, Boston and Pittsburgh. 1st Lt. Joseph F. Battley was assigned to New York as "Executive Officer" of non-existent facilities. The plan was to have a prominent Chemical manufacturer and member of the C.W.S. Advisory Board serve as a non-paid Chief. A Dollar-a-year man supposed to donate his services for prestige instead of profit. The staff was limited to one officer and a clerk-stenographer. The mission of the N. Y. Procurement District was to recapture the contacts made with Chemical and allied industries during World War I, set-up and maintain accurate files on the various Chemical facilities and manufacturers in the area as well as draw up plans for obtaining, in the event of an emergency, critical material apportioned by the Munitions Board through the Procurement Planning Division, OC-CWS. The material would be procured either from private industry or could be manufactured under government supervision on contract in privately-operated or arsenal manufacturing plants. Provisions were made also for the expansion of the New York District in the event of an emergency. The necessary military personnel would be drawn from Reserve Chemical Warfare Service Officers in the New York area. The Executive Officer of the District was also instructed to maintain close liaison with the Reserve Chemical Units and provide facilities for

on-the-job training for those Reserve Officers assigned to the Procurement Unit.

The Second Chemical Warfare Service Procurement District, predecessor to the current New York Chemical Procurement District, started operations on 24 January 1924 at 280 Madison Ave., N.Y.C., with Lt. Joseph F. Battley in charge. The Procurement Districts were under the direct supervision of the Procurement Planning Division of the Office of the Chief. Lt. Battley was succeeded on 9 September 1924 by Major Maurice B. Willett. On 3 September 1925 command of the District was transferred to Lt. George A. MacKay who on 29 April 1926 moved the office to 45 Broadway. On 27 August 1927, Capt. James H. Bogart assumed command of the District. He was succeeded by Capt. George F. Unmacht (now Col. ret.) on 19 May 1930. On 22 September 1932 Capt. Hubert B. Bramlet was appointed and continued until 20 January 1938. On 20 January 1938 Capt. Harry A. Kuhn assumed command,—this Capt. Kuhn first came to the Chemical Warfare Service as a 2nd Lt. from the U. S. Bureau of Mines and can truly be regarded with those early and loyal pioneers to whom this service owes so much. Capt. Kuhn's (now Col. U.S.A. ret.) service carried him through the hectic Lend-Lease and Post Pearl Harbor period when the N. Y. Procurement District grew from one officer and a secretary to 184 officers and 1,214 civilians on 29 September when Col. Patrick F. Powers assumed command. For the purpose of future history, it appears essential to list the following Commanders of this Class II Installation and dates of their tenure.

Commanding Officer	From	To
Col. Patrick F. Powers	29 Sep 42	10 Sep 44
Col. Sterling E. Whitesides	10 Sep 44	27 May 45
Col. S. N. Cummings (Actg.)	27 May 45	4 Jun 45
Col. Lester W. Hurd	4 Jun 45	16 Nov 45
Col. Patrick F. Powers	16 Nov 45	4 Mar 46
Col. H. M. Black	OCCWS SO 145 4 Mar 46	OCCWS SO 143 7 Oct 46
Col. G. J. B. Fisher	OCCWS SO 143 7 Oct 46	OCCWS GO 158 26 Nov 46
Lt. Col. R. W. Rothrock	OCCWS GO 158 26 Nov 46	OCCWS GO 7 22 Sep 47
Col. H. M. Woodward, Jr.	OCCWS GO 7 22 Sep 47	OCCMLC SO 5 12 Jan 48
Lt. Col. R. W. Rothrock	OCCMLC SO 5 12 Jan 48	Feb 48
Lt. Col. J. Escude	18 Feb 48	

As the Nazi war clouds gathered in Europe, the Chemical Corps was determined not to be caught unprepared as far as the procurement of supplies and manufacturers was concerned. In 1939 Col. Kuhn's staff was augmented by an Engineering Officer, Dr. Robert W. Rothrock (later Lt. Col.) and an additional clerk, Mr. Frank LeStrange. These four persons comprised the entire District until mid-summer 1940 when authorization was granted to increase the personnel to two military and twenty-two civilians.

Then as the "phony" Maginot War turned into an all-out attack and Britain increased her air strikes at the Nazis, the demands for incendiary munitions and protective masks skyrocketed. Then it was that the peace-time years of Procurement Planning by the Officer in charge of the District and the on-the-job training of the CWS Reservists in the New York area began to pay off. The files of the District contained complete information on the capabilities of the manufacturing plans in the area, reports on the security of the plants and the degree of cooperation that could be expected from their owners. There was also a well-trained nucleus of C.W.S. Reservists such as Lt. Col. A. J. Wilson, Colonels Tony D'Angelo, and Al Bowes to call on. In July 1940 three Reserve Officers on Active Duty Training drew up an Inspection Manual for use by the District Inspectors. The facilities of the Industrial Engi-

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neering Department of N.Y.U. were investigated as a possible location for an Inspector's Training School.

In October 1940, the District was activated as a Procurement agency of the Chemical Warfare Service. By the end of November, eleven officers were on duty and 35 contracts totalling approximately $3,000,000 had been let,—a far cry to the same time in years previous when $49.00 represented the total funds that were available for disbursement. Starting at this time, all regular and special meetings of the Chemical Reservists in New York were held at the District in order to create a greater awareness of the growing conflict and have the officers fully orientated on new procurement and inspection practices. Starting with January 1941, the number of contracts in effect varied from sixty-seven to as many as 196 per month. The number of personnel likewise increased steadily. During this formative period, Divisions and Departments in the District were named, redesignated and subdivided so many times as to preclude a listing of the changes here. In July 1941, five months before Pearl Harbor, the offices of the District were moved to 292 Madison Avenue where sufficient space to accommodate twenty-one military and seventy-nine civilians was available. On 20 December 1941, the N.Y. C.P.D. was designated as a military post with Lt. Colonel Harry A. Kuhn as the Commanding Officer.

The N.Y. C.P.D. was charged with the responsibility for procurement, production and inspection of C.W. materials and material for use by our Armed Forces and, to a degree, those of our allies. This material covered not only those items designated since World War I as Chemical, such as war gases, gas masks, chemical grenades, decontaminating apparatus, smoke pots, chemical mortars, but those newer developments such as incendiary fuels and bombs, flame throwers and smoke generators.

In sharp contrast to the feuding and fumbling of World War I, the District was determined not only to deliver the goods, but guarantee that it would be in the best working condition possible when it arrived either in the frozen areas or the tropics. Thus in July 1943, there was established in the District a sub-office of the Chief C.W.S. whose sole function was constant inspection of District purchases. This office was headed by a Reservist, Col. Tony D'Angelo. Hundreds of 2nd Lts., graduates of C.W.S., OCS as well as corresponding numbers of civilians were trained, in High School classrooms made available by the city, to be efficient specification sleuths. How effectively they did their work is attested by the fact that chemical munitions performed as expected in no matter where used in the global struggle against Dictators.

Then, due to the tremendous demands being made on industry by all branches of the Armed Forces and even the competitive bidding for chemicals by various installations within the same service, Gen. William N. Porter, Chief of C.W.S., established on 1 August 1944, within the N.Y. District, a Chemical Commodity Division that would be responsible for the procurement of all chemicals to be used by any installation or District within the C.W.S. This office was set under the direction of Lt. Col. Samuel N. Cummings (presently the Senior Cml C Reserve Officer in the N.Y. area and CO of Cml C Reserve Mobilization Detachment No. 10.) The New York Chemical Section surveyed and scoured the country for supplies of chemicals, issued manufacturing orders for chemicals to arsenals and C.W.S. operated plants and used best business methods to expedite shipments by plane, train or truck. At one time it operated a fleet of some 200 tank cars for use in transporting chemicals. In addition this New York Chemical Section also inaugurated a control of prices whereby prices on chemicals previously produced in small quantities were reduced as the production figures mounted from hundreds of pounds to thousands of tons.

Thanks to the years of Procurement Planning, it is very gratifying to know that between the award of the First Contract to the Globe Crayon Co. on 5 October 1940 to the end of hostilities, over $200,000,000 worth of Chemical items were produced on N.Y. C.W.P.D. contracts. It is highly important to note that during the same period $47,751,741 worth of contracts or almost one-fourth of the total amount were cancelled. This dollar value represented 702 contracts of which number 232 were settled with payments to Contractor and 470 at no cost to the Government. The reasons for such termination are as varied as changes in battlefield requirements for specific munitions and quantities, failure of an item to do the job intended or failure of contractor to meet production schedule or the manufactured product to measure up to specifications.

The Production Division as originally set up under Lt. Edward J. Hogy was divided into two major categories,—Inspection and Manufacturing. It was charged with responsibility for acceptance of C.W.S. items, seeing to it that the contractor understood his contract and the nature of the work he was to produce as well as evaluating his plant for production capability. Thus up to 28 April 1941, the Division performed the dual role of production and inspection. Green inspectors, in addition to their regular duties, were responsible for shipments, caring for government property, supervising personnel and handling enormous quantities of paperwork. This situation was the result of lack of authority to call up adequate engineering and production personnel. It quickly became evident to the Commanding Officers that too close contact between unrelated functions could be detrimental to the good of the Service and it was decided not only to separate conflicting functions, but also the personnel as well. In no case were inspectors allowed to grant waivers on the acceptance of any item. All such requests had to be processed through OC CWS to Edgewood Arsenal for action.

On 1 July 1941 a Plant Protection and Intelligence Department was set up as a section of the Production Division. However, as the volume of contracts grew, the workload on the Plant Protection Section was such that it was divorced from Manufacturing and established as a separate Division. On 10 January, Inspection was made a separate Division, but the Tool and Gauge Section remained with Manufacturing until it was logically transferred to Inspection on 30 November 1942.

Then, as the tempo of the war increased and stockpiles were being built-up for use in North Africa and England, the work

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of the District expanded tremendously under the impact of new Procurement Orders forwarded from Washington. Lack of coordination between material deliveries, tooling equipment and manpower resulted in confusion and failure to meet delivery deadlines. What was needed was a Production control system. Inspection had a control on shipments and component assembly, but more was required. Finally, the Commanding Officer ordered the transfer of these functions to a Production Control Division that by means of better coordination of delivery dates with manufacturers and arsenals helped keep up a steady stream of Chemical material to the Posts.

Here it seems fitting to comment on some of the production difficulties encountered in the early days of World War II. Many designs were improved, more were not properly executed for mass production, changes in military situations and climatic conditions necessitated many rush change orders, scarcity of manufacturers with "know how" and contractors with more anxiety than integrity, manufacturers accustomed to working in fractions of an inch were compelled to tolerances of thousands, others had little or no technical personnel. Manufacturers of women's bathing caps were converted to making gas masks outlet valves, stove manufacturers were making 4.2 mortar barrels, carpet manufacturers were converting to Flame thrower production. By its very name the Service attracted no end of chemists and laboratory technicians whereas the greatest need was for officers from the mechanical, industrial and manufacturing fields.

Although plans had been drawn for the creation of a Plant Protection Service in the early days of the District, it was not until 12 May 1941 that the Under-Secretary of War addressed a memorandum to the Chiefs of the Supply Services activating this continuing function of Procurement Service. Early in June the Plant Protection Inspection Service in the New York District actually got underway with the appointment of Capt. A. E. D'Angelo as head. As a result of the growing number of allocations and the fact that on 4 January 1942 the FBI was relieved of the responsibility for Plant Protection Surveys, this Plant Protection and Safety Section expanded rapidly. Supervision of fingerprinting of plant guards, procurement of their small arms and orientation as well as continuing accident prevention programs to conserve vital labor and reduce absenteeism by N. Y. Protection Officers resulted in an accident frequency factor that was well below the national average for the Chemical industry.

Procurement Division as of January 1942 consisted of the Planning Division, Procurement Division, Contract Control Division, Property Division, Manufacturing Division and Inspection.

Major A. J. P. Wilson was assigned in January 1942 as Chief, Planning Division with responsibility for establishing current and future procurement plans and maintenance of lists of allocated facilities.

Capt. A. N. Bowes was designated Chief of Procurement Division in charge of compiling of bidders lists, securing of bids, recommendations for awards, dissemination of information and guidance to successful contractors and subcontractors in the areas of Chemicals, Protective Appliances and Metals.

On 30 July 1942 Lt. Col. Max Waldenberg was assigned as overall Chief of both the Planning and Procurement Division with responsibilities for securing, tabulating bids, negotiation of new contracts and changes in established contracts. Later due to the changing requirements because of global warfare, this Division was again reorganized in August 1943 with Lt. Col. A. N. Bowes as Chief of the combined operation which comprised:

1) Planning Section; 2) Administrative Purchase Section; 3) Loading and Chemicals; 4) Protective Appliances. In December in the interest of securing a greater return for Government dollars, a Price Analysis Section was added.

Property and Transportation was another section that grew with increasing contract awards from 20 civilians in January 1942 to more than 120 in January 1944 in order to process an average of 2,000 bills of lading a month which represented in excess of 90,185,084 pounds of Chemical material.

On 28 September 1942 a Fiscal Division was inaugurated under Capt. Jack E. Buckley to handle the allocation of funds which work was formerly performed by a unit of the Contract Control Division. One of the primary functions of this Division was the application of a cost accounting-audit formula to the cost accounting system of contractor to whom awards were made, a review of terminated contracts and the preparation of data incident to the renegotiation of contracts. From an office formerly allotted $46.00 per year, the Fiscal Division in the first two years of its existence was allotted approximately $345,000,000.

As early as March 1943, a special division was set up to process contract termination claims. The problems of wartime termination of contracts where a new award replaces a terminated projection nowise compares to the end of the war termination of hostilities and the need for the commodity.

As the War progressed, the New York Chemical Procurement expanded its activities from supplying the usual Chemical Warfare items such as gas masks, chemical grenades, decontaminating apparatus, smoke pots to such highly specialized newer items as chemical and petroleum incendiaries, flame throwers and mobile smoke generators. An entire article could be written on the location, procurement and processing of Barium Chromate, Grained Aluminum, Thermit, Hexachlorethane and Napalm. But suffice it to say that the officers and civilians of the N.Y.C.P.D. procured it in quantities and had it delivered with such timeliness to the Air Force, that even before the advent of the Atomic Bomb, Japan had fewer military transport vehicles than New York City has taxicabs today. It is true that these results were obtained only after strenuous and stormy sessions between District and contractor representatives, but tempered judgment and direction by those in command kept ever before all the realization that both the military and the civilians were striving for the same end.

With the advent of V-J Day and the suddenly reduced requirements changed the emphasis from procurement to the equitable settlement of curtailed contracts. The District was not caught unprepared but immediately put into operation the long-prepared Post-War Termination-of-Contract Flan which had been operating on a greatly reduced basis since shifting theatre operations likewise changed troop requirements. Thus, from a war-time peak of several thousands of officers and civilians, by 31 December 1946, the staff had decreased to eight military and eighty-three civilians. The Office, likewise required less floor space and was moved to the Consolidated Edison Building at 111 East 16th St., New York City.

During World War II, overseas military requirements cut heavily into the military personnel of the District, with the result that now in the New York Area, there is to be found in Detachment No. 10 and other Chemical Corps Reserve Units, several cadres of officers not only fully trained in Procurement procedures, but possessing overseas troop experience as well. Today the peacetime mission of the New York District should be a peaceful one, a handful of Officers making surveys of facilities and studying end-item procurement as well as cooperating with the training of Reserve Chemical Officers in the Metropolitan area. However, the requirements of the conflict in Korea and the need to strengthen our Mutual Security Pact Allies, cause the District to operate on a full-time basis.

Today the N.Y.C.P.D. is a Class II Installation under the Commanding General, Materiel Command, in accordance with Section III of Administrative Order No. 34 OC Cml O 1 November 1951. The operational area of the New York District comprises the states of New York, Pennsylvania, New Jersey,

Delaware, Maryland, West Virginia, and the District of Columbia, with Headquarters located at 180 Varick St., New York 14, New York. While the N.Y.C.P.D. is under the military command of the Commanding General, Materiel Command, it comes under coordination control of the Commanding General, First Army for transportation records, administration, Signal activities and intelligence clearance.

As Colonel Joseph F. Escudé, the Commanding Officer of the N. Y. Chemical District, said in a recent speech to Reservists:

"The cost of conducting present day warfare is fantastically high, sufficiently high, in fact, to dislocate radically the economy of the Nation unless stringent controls are introduced to prevent economic chaos. In effect then, present day warfare from the viewpoint of strategic planning, causes a change in focus or a shift in emphasis from actual fighting on the battlefield to an increasing preponderance of attention and study to the logistical and economic concepts of waging war as it affects the overall war potential of the country. While the tactics and technique of conducting war continue to be critically important, supplies and logistics have become of over-riding importance since they strike directly at the ability of the country to wage war, centering as they do around the economic stability of the Nation.

"The keystone upon which our logistical program is based is, of course, the acquisition of supplies and equipment by procurement or manufacture. Since only a small number of items required by the Chemical Corps lend themselves to Arsenal manufacture, the great majority of military items are procured through Procurement Offices of the Chemical Corps."

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Thus, a Procurement District Officer must not only know the battle-field requirements of all the Armed Forces, but he must know where to locate a chemical item, produce it or procure it, test it and have it delivered at the right place and in the quantities required. The success of the N.Y.C.P.D. during World War II and in the present emergency has proved the value of working with a trained cadre of business, chemical and mechanical specialists in the Reserve Corps and maintaining their interest. As a Reservist who spent his vacation the past two summers at the N.Y.C.P.D. I can state that the cooperation, assistance and enthusiasm imparted by the Commanding Officer and personnel of the N.Y.C.P.D. could well serve as a "How-To-Do-It" Manual not only for the Chemical Corps, but also for the Service Branches of the Armed Forces.

ESTABLISHED PRIORITIES FOR V. A. HOSPITAL ADMISSION

Eligible veterans are now admitted to VA hospitals on the basis of nine new priority groupings, established by Congress to set up an equitable rule to govern the use of vacant beds for all persons eligible for admission or transfer to a particular VA hospital. Excluding emergency admissions, all eligible persons will be admitted in the following order of priority:

(1) War veterans and those who served since June 27, 1950, and who require hospitalization for service-connected disabilities.

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(7) War time, post-Korea, and certain other, veterans retired from the armed services for physical disabilities and not discharged for line of duty disabilities, who require hospitalization for nonservice-connected disabilities.

(8) Non-veterans whose hosptalization has been requested by authorized officials, excepting service personnel whose hospitalization is directed by the VA Central Office in Washington, D. C.

(9) All eligible veterans currently hospitalized in any other VA hospital who have requested transfer for personal reasons, but whose transfer is not necessary for medical reasons; and certain eligible veterans whom VA has hospitalized in non-VA hospitals, and who have requested transfer to VA hospitals for personal reasons, but whose transfer is not necessary for medical reasons.

Within these are various priority groups designated as "urgent" and "general," depending on the decision of the hospital manager or admitting physician. Under this order of consideration within priority groups, vacant beds will be utilized for persons in the "general" category only when there are no persons in the "urgent" category of the same priority group for whom the beds can be used. If a person scheduled for admission to a hospital fails to report within 15 days after the notification, and fails to give a valid explanation, his name will be placed at the bottom of the chronological listing within the priority group. Under extreme circumstances, his name will be removed entirely from the list and he will have to file a new application.

EXPLOITATION OF GERMAN CHEMICAL TECHNOLOGY

(Continued from page 12)

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Sharp & Dohme, Incorporated
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The Sherwin-Williams Co.
Smith, Kline & French Laboratories
E. R. Squibb & Sons
Standard Oil Company (Indiana)
Standard Oil Development Company
Stauffer Chemical Company
R. J. Strasenburgh Co.
Sun Oil Company
Tennessee Corporation
Tennessee Eastman Company (Division of Eastman Kodak Company)
Tennessee Products & Chemical Corporation
The Texas Company
Union Carbide and Carbon Corporation
U. S. Industrial Chemicals Co. (Division of National Distillers Products Corporation)
United States Rubber Company
Victor Chemical Works
Wallace & Tiernan Products, Incorporated
Westvaco Chemical Division (Food Machinery and Chemical Corporation)
Witco Chemical Company
Jacques Wolf & Co.
Wyandotte Chemicals Corporation
Wyeth, Incorporated
Zinsser & Company, Inc.

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New furfural plant at Omaha showing in the foreground a cutaway view of the chemical process section.

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Standard Oil Company (Indiana)
Standard Oil Development Company
Stauffer Chemical Company
R. J. Strasenburgh Co.
Sun Oil Company
Tennessee Corporation
Tennessee Eastman Company (Division of Eastman Kodak Company)
Tennessee Products & Chemical Corporation
The Texas Company
Union Carbide and Carbon Corporation
U. S. Industrial Chemicals Co. (Division of National Distillers Products Corporation)
United States Rubber Company
Victor Chemical Works
Wallace & Tiernan Products, Incorporated
Westvaco Chemical Division (Food Machinery and Chemical Corporation)
Witco Chemical Company
Jacques Wolf & Co.
Wyandotte Chemicals Corporation
Wyeth, Incorporated
Zinsser & Company, Inc.

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PVP

(Continued from page 26)

culation until such time as a transfusion can be given. When the loss of blood is less acute, the substitute alone may give adequate results.

Solutions of PVP with physiological salts are indicated for intravenous injection in pathological conditions characterized by a decreased circulating blood volume, as in shock and collapse due to mechanical injuries, trauma and operation, extensive burns, hemorrhage and dehydration. Because of its advantageous colloidal osmotic pressure and its prolonged stay in the blood stream of 2 to 3 days, PVP-saline successfully fulfills the requirements for a plasma expander.

Another important clinical application for PVP may lie in its use as a retarding vehicle for a large number of drugs. It has been shown, for instance, that PVP definitely increases the time during which penicillin is retained in the circulatory system, thus reducing the number of injections necessary to maintain a desired penicillin level in the patient's blood. Similar retarding capabilities were observed when PVP was used to prolong the activities of novacine, insulin, sodium salicylate and ACTH.

Still another interesting clinical property of this versatile material is its adsorbing power in vivo for several physiological and non-physiological products including bilirubin, Atabrine, vitamins B_1, C and P, numerous dyes and diphtheria, tetanus, botulinus and other toxins. The mechanism behind this interesting action has not yet been satisfactorily explained but it is in many ways similar to the detoxifying ability of natural blood plasma, thus extending PVP's capabilities as a blood plasma expander.

Another development of the GAF program is PVP-Iodine, a new efficacious, non-irritating, non-sensitizing detoxified germicide. Iodine, in this combination with PVP, retains its highly effective germicidal qualities but loses those irritating properties that have greatly restricted the use of iodine to date.

These other pharmaceutical applications of PVP are at present in the exploratory stage. Indications are, however, that the total volume of PVP required for these promising uses will be small and that their development will depend considerably upon whether or not substantial volumes of GAF PVP are required for its major use on a blood plasma expander.

PVP and Other Plasma Expanders

In the search for suitable blood plasma expanders, which antedates the first World War, many materials have been clinically evaluated. Most of them, however, have been found unsuitable mainly because of undesirable side-effects or their inability to be retained by the circulatory system long enough to be effective. In this group are such substances as salt solutions and solutions of various natural gums.

Currently, the two apparently most successful plasma expanders are PVP and dextran, a mixture of high molecular weight sugars produced by the action of a specific group of bacteria upon ordinary sugar, sucrose. The "crude" dextran, as first formed by this fermentation, is further processed and the desirable components (of the proper molecular weight) are removed and constitute the final refined dextran for clinical use.

Dextran has been given approval by the National Research Council and the Food and Drug Administration for general employment as a plasma expander. PVP has thus far been approved only for emergency stockpiling. There has been hesitancy to sanction unqualified use of PVP because of the fact that it is a totally synthetic product while dextran is manufactured from natural materials, a situation more acceptable to the medical profession. There is no record, however, of any case in which the use of PVP has been found to be the cause of harm to any body organ.

Whatever partial uncertainties still exist about the clinical application of PVP or any other plasma expander, the fact remains that only through further research can these difficulties, real or apparent, be resolved. And the strengthening of such research effort, whether it be industry or government-sponsored, seems the one logical way to assure America's security . . . if disaster should strike.

Leasing Plants Saves Dollars

A policy of leasing its stand-by munitions plants to private commercial firms instead of "moth-balling" them, is saving the U. S. Army millions of dollars annually, according to the Army Chemical Corps.

The Chemical Corps maintains a number of munitions production plants, ordinarily used only in wartime, but which must be kept in a constant state of readiness for full-scale production. To keep the plants operatable with maintenance crews would be an expensive operation. Chemical Corps supply officers have found that the Army can get this maintenance free and realize a tidy profit for the government by renting the plants to firms producing allied chemical products, such as insecticides, fertilizers, and dyes.

Of $183,815,526 worth of weapons plants held by the Chemical Corps in fiscal 1951, $71,332,808 were leased to commercials for a total rental of $1,263,636. To moth-ball those same plants would have cost the Army an estimated $1,500,000. This amounts to a total savings to the government of $2,763,636 or nearly four per cent of the cost of the plants.

Electric Saving

Dugway Proving Grounds, the Army Chemical Corps' test area and munitions production plant in the Utah desert, has recently switched over to the local commercial power company as its source of industrial and lighting electricity. Heretofore the base has furnished its own power with generators, but a recent check disclosed that the Army could buy its power cheaper than it could produce it. However, the base will retain its own generators on a stand-by basis, in the event of a power failure.

AND A VOICE SHALL BE HEARD

(Continued from page 14)

operate more than 600 radio-equipped vehicles throughout the county.

Civil Defense authorities will maintain only supervisory control over the various agencies, unless they are forced to take over for them in an emergency because of loss of radio equipment, power or personnel. The CD communications center can operate (1) as a station from which to supervise and coordinate the entire system, (2) as a mobile radio unit of any of the agencies, (3) as an auxiliary fixed station for any or all of the agencies should the need arise.

To do this, the "center" is equipped with a transmitter on a separate frequency for transmitting supervisory and coordinating messages, and a transmitter and receiver operating on the amateur frequencies. It further includes transmitters and receivers for each of the agencies.

The "center" is located in a large motor truck type-trailer, and is provided with auxiliary power producing equipment to insure operation in case of power failure. Several remote locations have been established for tying into telephone and power lines. As safety measures against possible sabotage, the center is moved from time to time, and is unidentified.

RESEARCH PROGRAM

(Continued from page 22)

of Applied Physiology for December 1951. Definitive conclusions and recommendations with descriptions of the methods were first presented as a Medical Laboratories Special Report in August 1951. These became official when they were approved by the Armed Forces Medical Policy Council, 5 November 1951.

Civilian agencies interested in the same question were kept informed of the research program. At a meeting called by the National Research Council for 1 October, 1951, the investigators summarized their findings and their conclusions for the benefit of representatives of all such groups. After the meeting was adjourned the investigators met with a number of National Research Council consultants to draft recommendations.

The final meeting was held at the National Research Council on 3 December; the purpose was to release to the press the research findings with conclusions and recommendations. Country-wide publication followed on 6 December. The American Red Cross and all other agencies which had been represented at the National Research Council meetings accepted the recommendations. In short, a research program costing about $25,000, supported jointly by the Medical Services in the Army, Navy, and Air Force and by the Chemical Corps, resulted in the country-wide adoption of the back-pressure arm-lift method of manual artificial respiration. A method that had been in general use for 40 years in this country was displaced by a superior method. This change will no doubt save many lives, both military and civilian.

It is hoped that this paper has acquainted you with:

The mission of Chemical Corps Medical Laboratories and of its component divisions and branches,

The professional talent devoted to accomplishing this mission,

Four sample research projects, one for each of the four research divisions,

And, finally, the possibilities of nation-wide application of the basic research for which Chemical Corps Medical Laboratories is responsible.

Improvement in Flame Throwers

The Army Chemical Corps has made improvements in two of the devices used for servicing incendiary weapons at the battle front.

One of these is a new adaptation of the mechanical mixer used for adding the Napalm thickening material to gasoline for filling fire bombs, flame throwers, land mines, and other incendiaries. The new mixing unit has several advantages over previous models—it is lighter, simpler to operate, more efficient, and produces a more uniform type of thickened fuel.

The other improvement is a new compressor for supplying the pressure to flame throwers. This model weighs only 60 pounds; its predecessor, the M-1 compressor weighted 850. One of the difficulties of the M-1 was that it was hard to get up close to the battle-front, since it had to be carried on a truck. The new one is designed to be carried on a man's back. Besides this, its low center of gravity allows it to be operated on rough terrain without danger of overturning. Already field tested in Korea, this new unit is providing an efficient solution to an old problem—that of getting flame throwers serviced at the closest possible point to the scene of action.

The new compressor does not have the capacity of the older one, but it will still pressurize three portable flame throwers at a time, taking about four minutes per tank. The M-1 could handle six, at the rate of two minutes per tank. Thus the new model has half the capacity of the older type, but weighs less than one fourteenth as much.

Shrapnel-Proof Vest

Specifically designed to stop all types of fragmentation missiles, a new shrapnel-proof vest has been tested for combat troops by the Chemical Corps. The new body armor is made of 12 layers of tough nylon. (A survey has shown that a large majority of battle-field wounds are caused by shell and grenade fragments—or shrapnel.)

The Chemical Corps tests were conducted at the Army Chemical Center, Edgewood, Maryland, and in Korea. A Corps representative was sent on three missions to Korea to expedite and coordinate the laboratory tests with actual battle conditions. The covering was originally developed by the Army Quartermaster and Medical Corps.

Some 3,000 men have worn these vests on patrols in Korea since testing began. The jacket not only raised morale, but also made the carrying-out of patrol and combat assignments less hazardous. The troops moved faster and the vest was credited with instilling tremendous amounts of confidence. During the actual battle test, some 40 men wearing the covering were hit by shell fragments and none suffered wounds in the protected areas.

Flamethrowers Not For Civilian Use

The successful use of portable flamethrowers in Korea by the United Nations forces has resulted in the Washington office of the Army's Chief Chemical Officer being flooded with requests for information regarding civilian use of this weapon. In answer to all such requests, the Chemical Corps points out that the flamethrower is an extremely dangerous piece of equipment and is for use on the battlefield only.

Most of these requests are from people wishing to clear land of underbrush or woods. According to Major General E. F. Bullene, Chief Chemical Officer of the Army, the amount of good a flamethrower can do in such work does not justify the extreme hazards to which a civilian operator would expose himself, his family and neighbors, and their property, with such a dangerous piece of equipment. Government agriculture and forestry agencies have experimented with the flamethrower for land clearing work and found that other means of burning are more effective. In answering such requests, the Chemical Corps ordinarly refers the writer to his county agricultural agent or nearest forest crew for advice.

Says General Bullene: "The flamethrower was developed by the Chemical Corps for use on the battlefield. It is an anti-personnel and incendiary weapon and an extremely dangerous piece of equipment. Even in the heat of battle 'just any' soldiers does not use flamethrower. Personnel thoroughly trained in its use are the only ones to operate this weapon."

NAPHTHOLS

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A REPORT ON THE SECOND INTERNATIONAL CONGRESS OF BIOCHEMISTRY

By RANDOLPH T. MAJOR
Vice President and Scientific Director
Merck & Co., Inc.

Over two thousand biochemists from over forty countries were in Paris, July 21-27, 1952, to attend the Second International Congress of Biochemistry. Over 350 of these were from the United States. Britain sent over 500 delegates, the Scandinavian countries about 200 and Russia, six.

Many of the most distinguished biochemists in the world, including a number of Nobel Prize winners, attended the Congress. The Honorary President of the Congress was Professor Gabriel Bertrand and the active President was Professor Rene Fabre, both distinguished French biochemists.

Others who took active parts in the sessions of the Congress included Professor A. Tiselius of the University of Upsala; Professor K. Linderstrom-Lang of the University of Copenhagen; Professor William G. Rose of the University of Illinois; Professor C. Fromageot of the University of Paris; Sir Rudolph Peters of Oxford University; Professor Edwin Cohn of Harvard University; Professor W. H. Peterson of the University of Wisconsin; Professor F. F. Nord of Fordham University; Professor P. S. Ochoa of New York University; Professor A. D. Welch of Western Reserve University; Professor G. Pincus of Worcester Polytechnic Institute; Dr. Fritz Lipman of the Massachusetts General Hospital; Professor C. W. Shoppee of the University of Birmingham; Professor E. B. Chain, Instituto Superiore di Sanita, Rome; Professor Linus Pauling of California Institute of Technology; Professor L. F. Fieser of Harvard University; Professor E. J. Bigwood of the University of Brussells and Professor J. E. Courtois of College of Pharmacy, Paris.

The sessions of the Congress were held in Sorbonne and neighboring University buildings. A number of dinner meetings of the various sections of the Congress were held in the Madison Internationale at Cite Universitaire on the outskirts of Paris. The official languages of the Congress were French and English. All papers were given in these languages, except those by the Russian members who spoke in Russian, but who distributed French translations of their addresses to their audiences.

The meeting was a memorable occasion and will long be remembered by those who attended it.

BOMB PROOF SHELTERS

(Continued from page 43)

ing of all essential services may be doubly assured. Such an installation will comprise:

1) 2—25 HP Diesel-generator sets with intake and exhaust ducts completely separated from the atmosphere of the shelter proper. Standby heavy-duty submarine-type batteries, also thoroughly isolated, will be capable of maintaining, at reduced levels, the essential services for a predetermined period, say 24 hours, i.e., air regeneration; emergency lighting; water and chemical pumps, etc.
2) 2—10 HP air-conditioning plants, complete with air filters, refrigerating coils, dehumidifiers, reheaters, fans, etc.
3) Carbon dioxide absorbers for the spent air.
4) Oxygen generators to replenish the portion consumed by human breathing.
5) Pumps for handling—water, fuel oil, chemicals, sewage, etc.
6) Fans and blowers for the air-conditioning system, repressuring, etc.
7) Air compressors.
8) An overhead sprinkler system for fire prevention.
9) Tanks for storage of—water, fuel oil, chemicals, sewage, etc.
10) Chemical latrines and ejectors.
11) Several, battery-powered, light Run-about trucks for servicing the shelter via the two gentle ramps which connect the shelter area with the surface.
12) A centrally operated telemotor control system which enables the crew manning the shelter command post to close within seconds the massive fire and gas-proof doors which separate the three compartments from each other and from the other vital zones, such as the engine room. A central indicator and regulating panel board will enable the commander to control the volume and condition of the air being supplied to any given sector, regulate the lighting, adjust the volume of loud speakers, operate the sprinkler and other fire-control systems as may be desired.

Plant Renovation Savings

A new mobile field impregnation plant, used by the Army to gas-proof troop combat uniforms and equipment in the event of an attack with poison gas, would cost $61,800 if bought new today. Chemical Corps maintenance teams have found that they can completely rebuild and modernize World War II models of the units for $37,800 apiece, and get a unit that is equal or better than a new model. Eighteen of the used units have thus far been refurbished at a total savings of $432,103, and a few of them are on hand in Korea. Incidentally, the units make excellent field laundries.

ALASKA

(Continued from page 7)

small game, including ducks, geese, spruce hen, ptarmigan and rabbit. In addition, there are various winter sports and winter activities such as ice fishing, skiing, snow-shoeing, ice-skating, tobogganing, and dog-sledding.

The army operates an attractive recreation center at Seward where one may spend several days relaxing and fishing during the summer months.

The Air Force operates recreation centers at Naknek and Skilak, where fishing is the main attraction, and a recreation center at Mt. McKinley Park during the winter months where winter sports are featured, all of which are available to army personnel.

There are numerous lakes and streams accessible by air, railroad and highway which provide a wide variety of fish, making Alaska a fisherman's paradise.

Fort Richardson operates the Arctic Valley Ski Bowl during the winter months for the benefit of ski enthusiasts and for the instruction of troops in basic and advanced skiing.

The serviceman in Alaska is welcomed by the civilian population and invited to participate in church and civic affairs as well as cultural, social, and recreational activities.

OVERSEAS TOUR

The present overseas tour in Alaska is two years except for the Port of Whittier. This station and certain other isolated posts have curtailed tours.

OPPORTUNITIES FOR CIVILIANS

As a matter of interest to the civilian reader, there are numerous positions in Alaska for federal civil service employees with Army, Navy, Air Force and other Federal agencies. However, it cannot be too strongly emphasized that individuals seeking work should make thorough preliminary inquiries by mail before starting to the Territory. During slack seasons work is scarce and during busy seasons housing is very difficult to obtain and prices are high.

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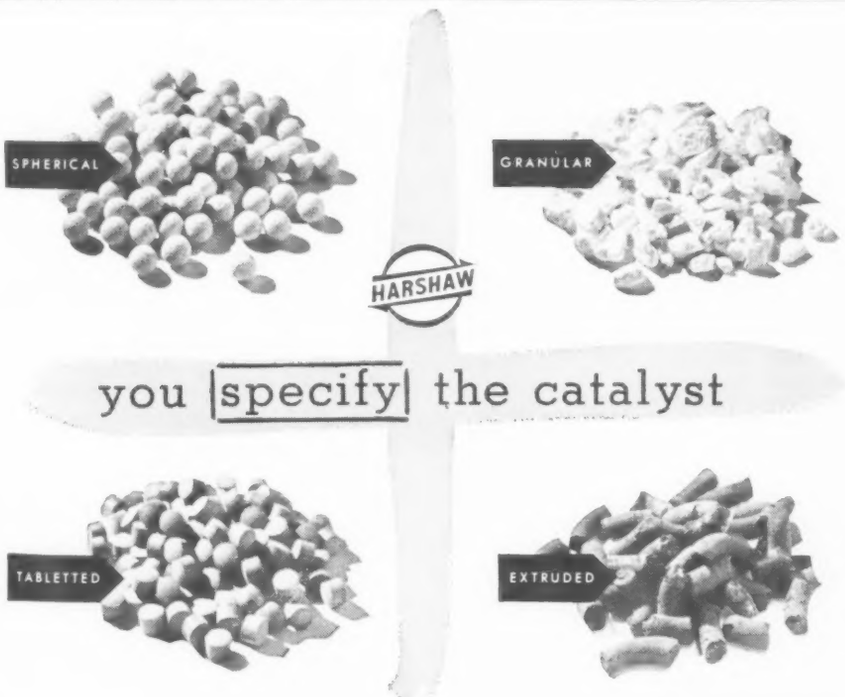

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• UNIT CITATION

MERITORIOUS AWARD TO THE 92ND CHEMICAL SERVICE CO.

Colonel Donald D. Bode, Largo, Florida, Chemical Officer of Eighth Army, presents Captain Alex R. Garrett, Montgomery, Alabama, commanding officer of the 92d Chemical Service Company, with the Meritorious Unit Citation awarded for the unit's outstanding work in support of combat operations in Korea. The company supplies chemical materiel to virtually the entire Korean front.

The 92d Chemical Service Company, commanded by Capt Alex R. Garrett of Montgomery, Alabama, has been awarded the Meritorious Unit Citation for outstanding support of combat operations in Korea for the period January 1 to June 30, 1952.

The company supplies virtually the entire Korean front through their depots and ammunition supply points. The company is a completely self-contained unit, able to carry out research, maintenance and supply operations. The ingenuity and varied talents of the men are apparent to even a casual observer. The chemical laboratory is manned by one officer and two enlisted men who are all graduate chemists. The vehicle repair shop would be the envy of small town garage owners. The warehouse and supply areas are extremely efficient, moving such items as flame throwers, land mines, decontamination trucks, smoke grenades and napalm in an endless stream.

The men of the company have developed their areas to the point where movie, PX's, barber shops and laundries are available to everyone in the unit. They have made their own shower units, graded roads and built warehouses when the Engineers were busy with higher priority projects. The company area at the headquarters is a model of efficiency and comfort seldom reached in a combat theater.

• IN 2d CHEMICAL BN.

MORTAR EXPERTS KEEP BUSY

By PVT. MARVIN A. BRODSKY

If historians of the Korean conflict ever single out any one group as the "most travelingest unit in Korea," that honor has a good chance to go to the 2d Chemical Mortar Bn. Having served in support of seven UN divisions, the men of this outfit are justified in claiming a stake to the title.

The only unit of its size now operating in Korea that fires the powerful 4.2 mortars exclusively, the 2d Bn. has been up and down this war-torn peninsula lending direct support to UN line troops since coming here last October.

The battalion can also boast of being the only Chemical Corps unit in Korea with combat troops.

* * *

Originated at the time of War I as the 2d Gas Regiment, the outfit has slowly evolved to its present form as a 4.2 mortar battalion. It was activated in April of 1935 as the 2d Chemical Mortar Bn. and it was during War II that the 4.2s were developed for the dispersion of chemicals.

At the close of War II the outfit was deactivated, only to be reactivated in December, 1948 at the Army Chemical Center, Md. After 20 months of intensive training there, it landed in Korea on October 8, 1950.

* * *

Strange as it may seem, these men have never been officially in reserve since joining UN forces here. Barring the time it took to move the men and equipment from the support of one division to another, the men can truthfully say they were off the line 48 hours in all, and even this was not official. This occurred during the latter part of April this year when the battalion was moved in to support the 6th ROK Division. Due to the fact that they had lost some equipment and needed time for regrouping, the men were then given a 48-hour rest period.

Because of the thorough training the unit was subjected to before landing in Korea, the men function as a closely-knit, well-coordinated group. Every man from the ammo bearer to the forward observer knows his job so well that it would seem as if a master hand were directing the operations when they bombard the enemy.

The squads get off as many as 20-30 rounds per minute. Considering that the tube has to be resighted constantly because of the soft ground, and that the mortar shells weigh 25 pounds and must be handled like new-born babes, this is quite a feat.

During the period of April 24-25, Co. A fired 1362 rounds in five hours, and on May 22-23 this same group got off 1976 rounds in less than seven hours.

* * *

For those who may think that all there is to firing a mortar is to drop the shell down the tube and duck, it may be well to pause and explain just how a mortar squad goes through their paces. In the first place, the men cannot see their target most of the time. Hence effectiveness depends solely on accurate computations. The forward observer is placed in a position where he knows exactly where the weapon is and where he can see the target. He relays the target information to the gunner on the mortar who then must take a sighting on an aiming stake placed before the gun mount.

BOOK REVIEWS

THE FISCHER-TROPSCH AND RELATED SYNTHESES. Henry H. Storch, Norma Golumbic, and Robert B. Anderson. John Wiley & Sons, Inc., New York, N. Y. 1951. 610 pages. $9.00.

This very complete reference work was compiled partially from the data collected by American and British technical intelligence teams which followed the victorious Allied Armies into Germany in 1945. The information gathered from the vast quantity of captured German documents, together with that obtained from the published literature on the subject, is summarized in detail and critically analyzed. The Fischer-Tropsch process, in which aliphatic organic compounds, mostly hydro-carbons and alcohols, are produced by the catalytic hydrogenation of carbon monoxide, continues to be of considerable interest to American technologists. Here for the first time we have the whole, well-documented subject under one cover. In addition, information is given on the "oxo" process and the iso-paraffin synthesis. The three Bureau of Mines scientists, who have prepared this treatise, are to be congratulated on a job well done.

OPERATION OVERLORD. Albert Norman. The Military Service Publishing Co., Harrisburg, Pa. 1952. 230 pages. $3.75.

One of the greatest operations in military history, and the largest overseas military operation ever undertaken, is described in a very readable style. Dr. Norman, Assistant Professor of History at Norwich University, served in France and Germany on General Omar Bradley's staff as historian of Headquarters, 12th Army Group. He is thus able to bring to the reader a first-hand account of the invasion of western Europe from England in the summer of 1944, a complex and overpowering operation which led to the defeat of Germany the following year. Following a foreword by General Bedell Smith, General Eisenhower's Chief of Staff, the subject is presented in four parts: The Strategic Problem, Organization for the Invasion, The Design, and The Reality. Of particular interest to members of the Armed Forces Chemical Association is that part of the assessment of German strategy which pertains to the possible use by the enemy of biological agents and poison gas. It was concluded that German research in biological warfare had not reached the stage that it could be considered as a practical weapon. Available evidence indicated, however, that German preparations for gas warfare were defensive rather than offensive. Preparations were made to retaliate immediately if the Germans resorted to chemical or biological warfare, and all Allied troops were provided with anti-gas equipment before they landed on the Normandy beaches. The book is interesting throughout to both the military man and the layman.

Principles of Geochemistry. Brian Mason. John Wiley & Sons, Inc., New York, N. Y. 1952. 276 pages. $5.00.

Legend into History. The Custer Mystery. Charles Kuhlman. The Stackpole Company, The Telegraph Press Building, Harrisburg, Pa. 1951. 250 pages and map of battlefield. $5.00.

The Military Instructor. Edward E. Pickard. The Military Service Publishing Company, Harrisburg, Pa. 1951. 369 pages (paper binding). Price not quoted.

Military Medical Manual. The Military Service Publishing Company, Harrisburg, Pa. Seventh Edition. 1952. 761 pages.

The Theory of Isotope Separation as Applied to the Large-Scale Production of U235. Karl Cohen. Edited by George M. Murphy. McGraw-Hill Book Co., Inc., New York, N. Y. 1951. 165 pages. $2.00.

Communication of Technical Information. Robert M. Dederich. Chemonomics, Inc., 400 Madison Ave., New York 17, N. Y. 1952. 116 pages (paper binding). $5.00.

RECENT LITERATURE OF NATIONAL DEFENSE INTEREST

Abstracted in *Technical Data Digest* (1952), published by Central Air Documents Office (Army-Navy-Air Force), Dayton 2, Ohio.

ELECTROCHEMICAL STUDIES OF PROTECTIVE COATINGS ON METALS, Pt. III, The Correlation Between Conductance or Capacitance and Area of Breakdown of Paint on Steel Immersed in Sea Water, F. Wormwell and D. M. Brasher; JOURNAL OF THE IRON AND STEEL INSTITUTE Nov. '51 (169-3 Mthly); pp 228-234; 10 illus. 2 tb.

The electrical conductance or capacitance of a pair of painted metal plates immersed in an electrolyte is not directly proportional to the area of paint breakdown because of (1) the spreading in the electrolyte of the "lines of conduction" between exposed areas, (2) the effect of the thickness of the rust deposit. By observing certain precautions an approximate estimate of the area of breakdown can nevertheless be obtained and hence the method may prove useful when the area is too ill-defined to be measured visually. For the paints and conditions investigated, the rate of penetration of corrosion at exposed areas is independent of the relative areas of exposed metal and of intact paint film. This suggests that no appreciable cathodic action occurs on the areas of intact paint.

PLATING METAL ON PLASTICS; PLASTICS INDUSTRY Dec '51 (9-12 Mthly); p 15; illus.

A new method of plating metal on Bakelite and Vinylite phenolic or styrene plastics is making available lightweight, corrosion-resistant products with hard, high-polish metal surfaces. Mass production techniques deposit a hard film of copper, silver, chromium, or other metal two to three thousandths of an inch thick on the surface of small plastic articles. Sandblasting or wet and dry tumbling of the molded plastic object are the first of four basic steps of the process. Following this a conductive bond coat is applied. Dipped for a minute or two in a sensitizing solution and rinsed, the plastic article is then given a thin bond coat of silver one-hundred thousandth of an inch thick by chemical reduction in a spraying or immersion operation. When dry, the bond coat is tested for electrical conductivity; 0.25 to 5 ohms is considered satisfactory. Metal plated items cost less to ship than solid metal, are more resilient, lighter to carry, and are highly resistant to heat, abrasion, and weathering.

SILICONE COATINGS PROTECT METALS, C. E. Arntzen and R. D. Rowley; MATERIALS AND METHODS Jan '52 (35-1 Mthly); pp 82-84; 5 illus, tb.

Silicone vehicles for baking enamels offer the possibility of securing high temperature and weather resistant flexible coatings not previously available. This article discusses the outstanding properties of the silicone finishes such as heat resistance, weathering and chemical resistance, and also the applications for which they are best suited. Tables offer more detailed information.

PREPARATION, PROPERTIES, AND TECHNOLOGY OF FLUORINE AND ORGANIC FLUORO COMPOUNDS (National Nuclear Energy Series), C. Slesser and S. R. Schram;

McGRAW-HILL BOOK COMPANY '51 (VII-1); 868 pp. illus, tb, eq.

The primary purpose of this volume is to present recent significant findings in the field of fluorine and fluorocarbon technology. These discoveries were accomplished under wartime Manhattan District contracts with academic institutions and industrial organizations in an attempt to prepare materials of extreme chemical inertness which were required in the plant engaged in the separation of uranium isotopes by gaseous diffusion. Volume I describes the large-scale manufacture of fluorine, including cell construction, electrolyte components, conditions of operation, and special engineering features; methods of handling fluorine, including purification and compression into cylinders, removal from waste gases and general health and safety precautions; preparation of new fluoro-organo compounds of chlorine by complete fluorination of organic compounds using fluorine carries; preparation and properties of products obtained by polymerizing chlorotrifluorethylene; and chemical and physical properties of various fluorocarbon compounds. Although the papers making up this volume represent the work of many authors, each paper is organized to treat its particular subject under the following headings: Introduction, Discussion, Experimental Work, and Summary. The two phases of work, industrial-scale operations and academic research and development, by virtue of the different problems encountered, are offered separately.

NATURE OF AIR RAID CASUALTIES, C. F. Enloe, Jr.; JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION 27 Oct '51 (147-9 Wkly); pp 858-862; 5 illus.

Should atomic attack come, the survival of the U. S. will depend upon the American medical profession more than upon any other group of citizens. Comparison of casualties experienced in the raids on German cities with those that occurred in the atomic bomb raids shows there was little difference in the type of injuries. Excluding radiation effects, which may be expected to account for about 20% of the total casualties, casualties may be classified as due to (1) external injuries and (2) internal injuries. Injury and death from mechanical causes head the list of casualties. Direct hits by flying debris, burial under rubble, and burns, may be expected to form the principal category of injuries. Those sheltered from mechanical injuries may face the greater peril of fire. Internal injuries will include carbon monoxide poisoning, heat stroke, dust inhalation, and psychomatic collapse. This paper is one of a series requested by the Council on National Emergency Medical Service.

TITANIUM AND ZIRCONIUM—Emergency Substitutes for Manganese, W. W. Austin, Jr.; STEEL 5 Nov. '51 (129-19 Wkly); pp 110-115; 3 ills, 1 tb.

Supply of suitable raw materials is one of the most acute problems facing our rapidly expanding steel industry, and manganese may be singled out as the most critical in terms of domestic availability. One approach to the problem of manganese conservation has been that of finding satisfactory substitutes for manganese in steel making. Results of investigations on zirconium and titanium show good promise as substitute materials and impart a number of distinctly beneficial properties to the steel. In spite of the promising results obtained with zirconium additions, there are two distinct disadvantages pertaining to its use as a manganese substitute. These are its poor availability from domestic sources, and the relatively high silicon content present in commercial zirconium alloys. Consequently, the outlook for extensive use of zirconium as a substitute for manganese in steel making, even as an emergency measure, seems rather remote at the present time. Titanium on the other hand appears to have considerably greater possibilities than zirconium as a substitute. Its behavior with respect to hot workability in low manganese steel has been found to be altogether satisfactory. In the experimental work thus far, a distinct advantage favoring the use of titanium over zirconium has been noted with regard to the relative retention of these elements upon addition to molten steel. Cost-wise, titanium is slightly more than twice as expensive as zirconium considering both in the form of commercial ferroalloys.

TRENDS IN AIR FORCE RESEARCH AND DEVELOPMENT, Maj Gen D. L. Putt; SAE PREPRINT 3-6 Oct '51 (Preprint); 13 pp.

The Air Force Research and Development organization is concerned with the qualitative concept of modern air power and is charged with the responsibility for the qualitative performance of all Air Force materiel from conception to obsolence. General Putt focuses attention on the complex problems in the many fields concerned with maintaining technological superiority. Basic research is being directed in physics, chemistry, metallurgy, and the geophysic sciences. Pioneering also is underway in human engineering. But the greatest Research and Development effort is being directed into applied research on aircraft, guided missiles, armament, electronics, propulsion, hydraulics, and supporting or related equipment. The over-all mission of the Air Force is of staggering magnitude. In broad strokes, General Putt presents the problems and what is being done to meet them.

TITANIUM, ZIRCONIUM, MOLYBDENUM, TUNGSTEN, TANTALUM, COLUMBIUM, VANADIUM, HAFNIUM AS ENGINEERING MATERIALS (Manual No. 77), J. L. Everhart; MATERIALS & METHODS Dec '51 (34-6 Mthly); pp 89-104; 22 illus.

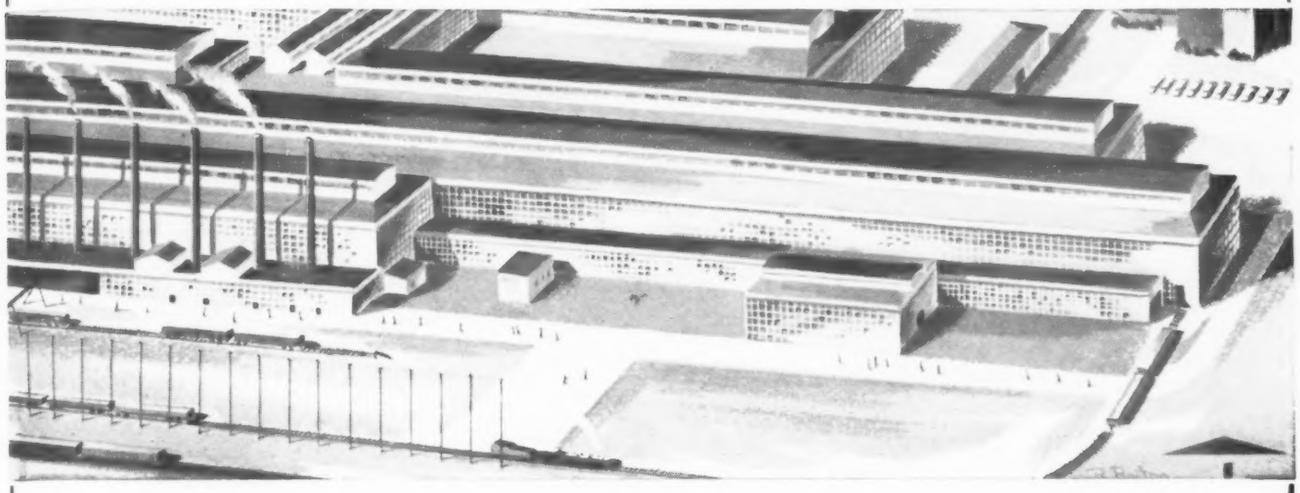
These eight metals, which at first glance appear to be a heterogeneous group, have a number of attributes in common, including high melting points and sensitivity to gases. All can now be either hot or cold worked and have been developed to the point where they are now suitable for a wider range of uses. This manual discusses the following: engineering properties; forming and machining characteristics; weldability; cleaning and finishing characteristics; and present and potential uses. Detailed tables accompany the presentation.

Abstracted in *Technical Data Digest* (1951), published by Central Air Documents Office (Army-Navy-Air Force), Dayton 2, Ohio.

HEAT MOLDING OF PLEXIGLAS TUBING FOR THE CHEMICAL INDUSTRY (Warmverformen von Rohren aus Plexiglas in der chemischen Industrie), H. Schmidbauer; CHEMIE-INGENIEUR-TECHNIK 28 July '51 (23-14 Bi-Wkly); pp 342-345; 11 illus, 1 tb, eq.

Most Plexiglas tubing used in the chemical industry is of the seamless type, with elastic properties in a temperature range between 120° and 160° C. In bending the tubes consideration must be given to the geometrical relationship between inner diameter, wall thickness, and radius of curvature. Radii smaller than 2.5 to 3 diameter should not be used since they may lead to buckling during the forming process. The tubes may be bent with or without chalk filling, using a hot air blower with a stream temperature of approximately 200°C. Caution must be exercised to avoid overheating of any portion of the tubing because of the poor heat conductivity of the Plexiglas. Large forms such as flasks or bottles may be blown, but require female dies of plaster. Elastically formed tubing tends to assume its original shape at 100°C. This property may be successfully used for shrink-fitting.

New developments at DOW



MAGNESIUM MILESTONE *at* Dow's *new Madison Plant*

A significant development in magnesium is taking place at Dow's newly acquired magnesium plant at Madison, Illinois. Dow, long a pioneer in the production and fabrication of magnesium, is installing the *first and only magnesium coil rolling mill in existence today.*

Other mills for magnesium are hand operations in which 140 lb. slabs are broken down and rolled a sheet at a time to a maximum of 48 inches in width. Dow's new mill will process 2,000 lb. slabs on 84 inch rolls, marking a tremendous advancement in production methods and resulting production capacity.

This increased production will be welcomed by the armed forces as well as by civilian users, for magnesium is playing an expanding role in defense efforts. This is particularly true in airplane construction where the light weight and high structural strength of magnesium combine to help make faster, sturdier, longer-range aircraft.

The Madison plant, which has 1,400,000 square feet of floor space and 110 acres of land within its boundaries, will house not only this magnesium mill but also facilities for extrusion and alloy operations. It is but one of the many new developments that indicate the continual growth and expansion taking place at The Dow Chemical Company.

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Have you recently studied the advantages in changing from 50% liquid caustic soda to 73%? A number of Columbia-Southern customers have made the change and in every instance the results have proved conclusive: A HIGH PROFIT RETURN ON EVERY CARLOAD OF 73% CONSUMED.

Here's an actual case study of three typical Columbia-Southern customers who made the change.

Customer	Cost of 50% liquid	Cost of 73% liquid	Per Cent of Savings	Total $ Savings per year	Cost of equipment and installation necessary to effect such savings	Return on Investment First Year
A	$ 68,240	$ 65,390	4.2%	$ 2,850	$2,650	108%
B	704,600	669,500	5%	35,100	3,500	1003%
C	171,800	164,500	4.3%	7,300	2,055	355%

Cost figures are based on market prices and freight rates effective January 1, 1952

As you will note from the study, the cost of the equipment and installation necessary for this profitable changeover is more than offset by the first year's savings. The small investment earns big dividends.

It will pay you to investigate today the extra profits that may be yours by making this change in your purchase of caustic soda. There is no problem in securing the diluting equipment. The system has been thoroughly tested and proved by over 10 years actual experience in applying high grade 73% caustic soda.

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